SCIENCE ABSTRACTS.

Section A.—PHYSICS.

JULY 1925.

GENERAL PHYSICS.

1535. *A Pressure-Time Recorder for Closed Vessel Experiments.* **D. R. Pye.** (Journ. Sci. Instruments, 2. pp. 188–193, March, 1925.)—The article describes a pressure-time recorder which employs a piston with an oil seal of which the movement is controlled by a stiff cantilever spring. The record is traced by a pointed stylus on polished celluloid wrapped round a uniformly rotating drum. The normal maximum deflection is 1–22 mm. Deflections can be read under a microscope to about 1/500 mm. The time record is given by a stylus attached to a tuning-fork which traces a record side by side with the pressure record. Enlargements of specimen records are given of experiments in which a combustible gaseous mixture is first compressed in about 1/10 sec. and subsequently ignites spontaneously after a period of delayed combustion. AUTHOR.

1536. *Hot-Wire Instruments for Measuring Altitude.* **E. Huguenard, A. Magnan** and **A. Planiol.** (Comptes Rendus, 180. pp. 828–830, March 16, 1925.)—The heat lost by radiation and convection from a heated wire depends upon the density of the atmosphere, and hence the latter may be measured by the current necessary to maintain the wire at constant temperature. Two platinum wires of 25 μ diameter and 7 cm. long are mounted in parallel and heated by current from a 16-volt battery. Another battery of 18 volts is connected through a variable resistance so that a voltmeter included in the first circuit reads zero when the hot wires are in air at 760 mm. pressure and 20° C. The instrument is calibrated by taking readings of the voltmeter at various reduced pressures. It is claimed that the instrument is eight times as sensitive as a barometer at an altitude of 14,000 m. F. S.

1537. *Employment of Photoelectric Cells in the Registration of the Oscillations of Pendulums.* **G. Ferrié.** (Bull. Astronomique, 4. 5. (Ser. 2) pp. 445–459, 1924.)—A detailed description, with illustrations of apparatus and diagrams of electrical circuits and optical arrangements, of the method of recording and maintaining the beats of high-precision pendulums referred to in the next Abstract. For preliminary studies on this subject see Abstract 1915 (1924). A. B. C. L.

1538. *The Use of Photoelectric Cells in the Observation and Maintenance of Astronomical Pendulums.* **G. Ferrié** and **R. Jouaust.** (Comptes Rendus, 180. pp. 1145–1148, April 14, 1925.)—To overcome inaccuracies in recording the beats of high-precision astronomical pendulums, caused by variations in the edges of the teeth of escapement wheels and mechanical defects in the closure of electrical contacts, a special optical and photoelectric method of control is resorted to. The pendulum carries a mirror so arranged in relation to a suitable source of light that at the middle of each double oscillation (at intervals of one beat in the vertical position) the reflected beam actuates a potassium photoelectric cell, the current produced being amplified by lamps of 3 and 4 electrodes. By means of an attachment of a solenoid and magnet, this amplified current can be used not only for recording purposes, both telephonic and by the maintenance of subsidiary chronographic pendulums, but also for the maintenance of the pendulum giving rise to the impulses. By such means errors can be reduced to less than 1/10,000 sec. A. B. C. L.

1539. *Equilibria in Systems in which Phases are separated by a Semi-permeable Membrane. I and II.* **F. A. H. Schreinemakers.** (K. Akad. Amsterdam, Proc. 27. 9–10. pp. 701–720, 1924.)—These systems are treated on a thermodynamic basis, two principal cases being distinguished: (1) All the liquids considered remain homogeneous, no demixing occurring; (2) with some of the liquids demixing does take place. The more important conclusions deduced are as follows: Two liquids, each saturated with the same solid substance, are isotonic with respect to this substance, so that all liquids in equilibrium with ice are isotonic with respect to water, no matter what substances the liquids contain. Also all liquids saturated with sugar or with urea or with sugar and urea are isotonic with respect to sugar or to urea or to sugar and urea, no matter what other substances are present. Liquids saturated respectively with $X + Y + Z$ and $X + Y + U$ are isotonic with respect to X and Y, but not with respect to U and Z. These considerations may be extended to the case of two liquids, each in equilibrium with the same vapour, such liquids being isotonic with respect to the substance of which this vapour consists. All liquids in equilibrium with, say, water-vapour are hence isotonic with respect to water, no matter what substances are present in the different liquids. Further, when a liquid L is in equilibrium with a vapour W, all liquids isotonic with L and containing no volatile substance other than W may also be in equilibrium with the vapour W. In a binary equilibrium in which demixing may occur, for definite values of T and P only two isotonic liquids can exist. The diffusion pressure of a substance W into a liquid is dependent on the concentration not only of W, but also of the other substances present in the liquid. The diffusion pressure of a substance in a binary mixture may be either diminished or augmented by addition of another substance; in the latter case this pressure passes through a maximum value and then decreases. T. H. P.

1540. *Determination of the Viscosity of Water.* **le Roux.** (Comptes Rendus, 180. pp. 914–916, March 23, 1925.)—The viscosity of water is measured by the coaxial cylinder method for every 5° between 0° and 50° C. The results are probably considerably more exact than any that have been obtained hitherto, the error being less than ½ %. An attempt to discover anomalous behaviour at 4° C. is not successful, and, within the limits of the experiment, the viscosity is independent of the velocity gradient. A. Wh.

1541. *Viscosities of the Liquid Halogens.* **E. W. R. Steacie** and **F. M. G. Johnson.** (Am. Chem. Soc., J. 47. pp. 754–762, March, 1925.)—The preparation and special purification of the substances employed for the determinations are described. The viscometers employed are adapted to overcome special difficulties arising from the properties of each particular halogen; *e.g.*, in the case of I, which in the liquid state leaves an opaque film on the glass of the capillary tube, the positions of the liquid are recorded electrically. The values obtained at the boiling-points of the respective halogens show an increase with increasing atomic weight, as would be expected from the periodic law. The general form of the viscosity-temperature curve also changes. A. B. C. L.

1542. *The Viscosity of Liquids containing Dissolved Gases.* **J. R. Lewis.** (Am. Chem. Soc., J. 47. pp. 626–640, March, 1925.)—The viscosities of the following solutions were measured with a modified Washburn viscometer, which is suitable for determining the viscosity of liquids containing dissolved gases: sulphur dioxide in carbon tetrachloride, acetone, benzene, xylene, ether, heptane, carbon disulphide, chloroform, and in acetone water mixtures, chlorine in carbon tetrachloride, hydrogen sulphide in chloroform. The concentrations varied from zero to saturation, pressure atmospheric, temperature 25°. The results obtained are shown in curves and tables, and it appears that the change in viscosity due to the dissolved gas depends on its solubility, on the viscosity of the solvent, on the viscosity of the gas condensed into liquid form at the temperature at which the measurements are made, and on the chemical nature of the solvent and the solute. A modified Ostwald viscometer was employed for solutions containing gas under pressure; the viscosity and fluidity curves have been determined for sulphur dioxide in acetone, ether, toluene, benzene, methyl alcohol and carbon tetrachloride, the concentrations being varied from 0 to 100 %, and the density curves determined. H. N. A.

1543. *Application of Theory of Elasticity to Plastic Deformations.* **E. Hungerer** and **J. Koenigsberger.** (Zeits. f. Physik, 31. 12. pp. 903–913, 1925.)—In this paper it is shown theoretically (and confirmed by an experimental case) that the geometrical form of a slightly deformed plastic body may be obtained from the classical theory of elasticity in the same way as for the perfectly elastic body. E. H. B.

1544. *General Mechanism of Synchronisation.* **J. Andrade.** (Comptes Rendus, 180. pp. 1148–1150, April 14, 1925.)—An analytical study of the general conditions of synchronisation of the damped rotary oscillations of a pendular system under the action of a given periodic perturbing force. A. B. C. L.

1545. *An Experimental Study of the Vibrations in the Blades and Shaft of an Airscrew.* **A. Fage.** (Roy. Soc., Proc. 107. pp. 451–469, March 2, 1925.)—This investigation deals with the natural frequencies of flexual vibration of the blades and shaft of a rotating airscrew, and includes a comparison of theoretical results with those determined experimentally from an analysis of the sounds emitted. The latter include three different groups, comprising the sounds of rotation due to the spiral movements of the sources and sinks, accounting for the pressure differences on the blades, the tearing sounds due to the shedding of eddies from the blades —these are of very high pitch—and sounds arising from the vibrations of the airscrew blades and the shaft. The frequency measurements were made with a hot-wire microphone and a four-valve amplifier. An account is given of the airscrew apparatus employed for the tests, which were conducted on four different airscrews, forming a family, the blades being of cast aluminium and clamped into a large metal boss. The sounds of rotation were analysed and found to be compounded of a large number of harmonics having as the fundamental a note of frequency equal to the product of the number of blades and the rotational speed. The measured frequencies of the shaft vibrations agreed very closely with the calculated results except for a discrepancy of 8 % in the case of the largest airscrew tested. The experiments on blade vibration appear to support the approximate formula of Southwell and Gough, namely: $p^2 = p_0^2 + aw^2$, where p_0 is the frequency of the gravest mode of vibration in the absence of rotation, and a is a constant. Close agreement between the theoretical and experimental values of both p_0 and a were obtained on long narrow blades; the agreement was less satisfactory for the widest blades of the series. A. W. J.

1546. *Ultimate Rational Units and Dimensional Theory.* **G. N. Lewis.** (Phil. Mag. 49. pp. 739–750, April, 1925.)—This paper is a reply to criticism of the theory of ultimate rational units (U.R.U.) [see Abstract 1005 (1923), and a trenchant one by Campbell, Abstract 1331 (1924)]. Bridgman also, in his book on "Dimensional Analysis," describes the U.R.U. theory as quasi-mystical in character, a point of view which is now closely examined. Feelings of opposition are held by the author to spring from certain prevailing ideas concerning the dimensions of physical quantities; so he seeks to show that the theory of U.R.U. may be presented without any statement or implication respecting dimensions. The argument now developed is treated in the following sections: The simplest statement of the theory of U.R.U.; What is a simple number? Is there a mystical element in the theory? The dimensions of physical quantities. The paper should be consulted in its entirety, and reference also made to a recent paper by Ehrenfest (Math. Ann. lxxvii. pp. 259–276, 1916), where a complete analysis of the dimensional problem is given in an extremely satisfactory form. H. H. Ho.

1547. *A Theorem in Tidal Dynamics.* **J. Proudman.** (Phil. Mag. 49. pp. 570–579, March, 1925.)—This paper mathematically describes a theorem with corollaries which avoids the chief difficulty of tidal problems and provides the means of calculating the elevation at any point inside a closed curve, provided the elevation and normal current all round the curve be known and frictional forces inside the curve can be neglected. Functions are developed from the general equations of the tides which enable direct computations, and if the depth be regarded as uniform the latter are represented with great ease. Applications are made to a flat sea and ocean of uniform depth. H. H. Ho.

1548. *Physical System of the Elements.* **C. G. Bedreag.** (Comptes Rendus, 180. pp. 653–655, March 2, 1925.)—An argument is developed on the basis of electronic theory to account for the several valencies and varying degree of chemical affinity possessed by certain elements. A. B. C. L.

1549. *International Atomic Weights,* 1925. *Second Report of the International Committee on Chemical Elements.* (Am. Chem. Soc., J. 47. pp. 597–601, March, 1925.)

1550. *Fundamental Atomic Weights.* **E. Moles.** (Zeits. phys. Chem. 115. pp. 61–90, Feb., 1925.)—Criticises and recalculates the whole of the physico-chemical and the modern chemical results, which can be regarded as precision measurements, and finds the following atomic weights referred to oxygen as 16: hydrogen 1·00777, chlorine 35·458, bromine 79·918. These values agree sufficiently well with those deduced from purely chemical measurements, and the conclusion can be drawn that there is no real difference between the chemical and physico-chemical values. This conclusion is due to the fact that more accurate values for the density and compressibility of oxygen, hydrogen, hydrogen chloride and hydrogen bromide are now available. The atomic weight of silver is not, as Richards and Baxter claim, less than 107·880, but somewhat greater, namely, Ag = 107·882. It is certain that the figure in the second decimal place must be eight. H. N. A.

1551. *Atomic Numbers and the Approach of Ions in a Crystal Lattice.* **A. F. Scott.** (J. Phys. Chem. 29. pp. 304–318, March, 1925.)—It is shown that the closest approach of ions in a crystal lattice, d, is related to the atomic numbers N_a and N_b by the relation $d = a \log_e (N_a - N_b) + b$, where a and b are constants. In the case of metals themselves, it is necessary to allow for the "electron ion," which is numerically equal to the valency of the metal ion. Then the expression becomes $d = a \log_e (N + e) + b$. The values of $\log_e (N + e)$ are given for most of the metallic elements. If the value of d be plotted against the value of $\log_e (N + e)$, a series of lines are obtained for each group of elements. These lines are straight both above and below the elements argon, potassium, calcium, scandium and titanium, but at this point exhibit a sharp bend. This is linked up with Bohr's theory that above argon electrons may go into the inner shell to fill up vacant places instead of invariably attaching themselves to the outer shell. It is also shown that the compressibilities and melting-points of the metals appear to be connected with the same function of the atomic numbers. Particularly attention is concentrated on the alkali halides, as for these an unusually accurate series of data is available. The calculated distance of the ions in these compounds is compared with the values from several other sources, and the agreement is shown to be very close. A. Wh.

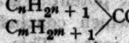
1552. *Direct Measurement of the Mean Free Path of Uncharged Silver Atoms in Nitrogen.* **F. Bielz.** (Zeits. f. Physik, 32. 2. pp. 81–102, 1925.)—Makes use of the uncharged atomic "rays" of silver, employed by Stern in other investigations; these pass through a narrow tube, from a chamber containing silver, which is heated in an electric oven, into a quartz tube above, which is kept cool and is filled with nitrogen at a low pressure. Three small glass plates at different heights can be moved in turn into the axis of the quartz tube by means of a megnetic arrangement, so that each of them stands in the path of the narrow beam of silver atoms for a definite time. The lower one, which is near the entrance tube, will condense all the atoms which emerge during this time, but those at a distance from the entrance will condense a smaller number, since some atoms will be deflected before reaching the plates by collision with nitrogen molecules. The thicknesses of the silver films were measured by Wiener's optical method, and it was shown that the product of pressure and mean free path was constant, within the limits of experimental error, for pressures from 1 to 7×10^{-3} mm. Hg. From the value obtained for this product it was possible to calculate the radius of the uncharged silver atom, which was found to be 1·0 Å. This is remarkably small when compared with the value for the monovalent silver ion, as given by Herzfeld. H. N. A.

1553. *Theoretical Stoichiometry of the Space occupied, and the Intermolecular Forces, in Liquid Organic Compounds. I and II.* **E. Wöhlisch.** (Phys. Zeits. 26. pp. 170–176 and 177–184, Feb. 1, 1925.)—The dependence of the true molecular volume on the structure of an organic molecule has been studied with the help of: the molecular volume at the boiling-point; the true molecular volume of the van der Waals theory, $\Phi = \frac{R}{32} \cdot \frac{T_k}{p_k}$; the critical molecular volume; the molecular cross-sections calculated from the viscosity in the state of vapour, and from Winkelmann's observations on diffusion in vapours; the molecular refraction; the diameter of the molecule calculated, according to W. Thomson, from molecular volume, surface tension, and heat of vaporisation. The van der Waals true volumes and those deduced from the viscosities of vapours show dependency on the structure of the molecule, as also do the volumes at the critical and boiling-points under some conditions. No use can be made in this respect of the molecular refraction and the W. Thomson molecular diameter. With rise in boiling-point there always corresponds lowering of the intermolecular volume, even in cases where the total molecular volume increases with the boiling-point. Acids have larger true volumes, and smaller intermolecular and total volumes, than the isomeric esters; the same relation appears to hold between the alcohols and the isomeric ethers. Branching in a hydrocarbon chain diminishes the true volume and increases the intermolecular volume. Accumulation of chlorine at a carbon atom diminishes the true volume and increases the intermolecular and total volumes.

T. H. P.

1554. *The Crystal Structure of Lithium Potassium Sulphate.* **A. J. Bradley.** (Phil. Mag. 49. pp. 1225–1237, June, 1925.)—The apparatus and experimental methods have been described previously [Abstract 1686 (1924)], the powder method having been employed, and measurements having also been made on a single crystal, using the X-ray spectrometer. A distribution of the atoms has been worked out which gives intensities corresponding closely with those observed, and which is shown in projection on a plane perpendicular to the hexagonal axis and on a plane parallel to this axis in the original paper. The unit cell is a hexagonal prism, the side of the base being 5·13 Å. and the height 8·60 Å. The potassium ions are on a simple hexagonal lattice of axial ratio $a : c = 1 : 0{\cdot}836$; the sulphate ions comprise two simple hexagonal lattices, axial ratio $1 : 1{\cdot}6755$, which fit together as if the sulphate ions were spheres in hexagonal close packing; lithium ions alternate with sulphate ions; each SO_4 ion has six K as neighbours, and each K is surrounded by six SO_4 ions. The O atoms are arranged round the S in tetrahedra, three are equidistant from the S, and the distance of the fourth must be nearly the same, actual distance 1·5 to 1·6 Å. A model has been prepared; the size of the unit is determined almost solely by the size of the sulphate ions, the metallic ions filling up, as far as possible, the interstices between them. H. N. A.

1555. *The Rare Earths and the Magneton.* **B. Cabrera.** (Comptes Rendus, 180. pp. 668–671, March 2, 1925.)—In the case of the rare earths the electronic level, which is being built up as one proceeds to higher atomic numbers and where the magnetic moments originate, is deeply seated, so that chemical actions do not affect it as much as they do in the case of the iron group; this is shown clearly in recent experiments by Woltjer and K. Onnes on $Gd_2(SO_4)_38H_2O$. The author has found the same to be more or less exact for all these elements, using oxides and sulphates, and has made a series of measurements with salts defined by the general formula $M_2(SO_4)_38H_2O$. The values found for *n*, the number of Weiss magnetons, are as follows: La^{+++} 0, Ce^{+++} 11·89, Pr^{+++} 17·89, Nd^{+++} 18·00, Sm^{+++} 7·64 (?), Eu^{+++} 17·92, Gd^{+++} 40·07, Tb^{+++} 47·92, Dy^{+++} 52·25, Ho^{+++} 52·00, Er^{+++} 46·98, Tu^{+++} 35·85, Yb^{+++} 21·64, Lu^{+++} 0. It is probable that the atom of Sm, in which *n* is distinctly fractional, is itself diamagnetic; to obtain $n = 8$ the diamagnetic susceptibility would have to be -97×10^6. The variations of the other values of *n* from whole numbers are discussed, and it is concluded from other experiments that gadolinium exists in two magnetic states with 38 and 40 magnetons respectively. The form of the graph showing the relation between *n* and the atomic number is discussed, particularly in relation to the portion between Sm^{+++} and Eu^{+++}; and conclusions are drawn as to the way in which the successive electrons are added to the layers in proceeding from element to element. H. N. A.

1556. *An X-Ray Investigation of Saturated Aliphatic Ketones.* **W. B. Saville** and **G. Shearer.** (Chem. Soc., J. 127. pp. 591–598, March, 1925.)—A continuation of work on the fatty acids and their esters by Müller and Shearer [Abstracts 755 and 756 (1924)]. The ketones group themselves into two sets, in each of which the continued addition of CH_2 groups to the molecule causes uniform growth of the spacing. In Group I the spacings indicate that a single molecule exists between the successive reflecting planes; in Group II the spacings are twice as long. In both cases it appears that the carbon atoms form a single long chain, so that the graphic formula should be $C_nH_{2n+1}.CO.C_mH_{2m+1}$ and not  $\begin{matrix}C_nH_{2n+1}\\C_mH_{2m+1}\end{matrix}\!\!>CO$. Group II consists of the methyl ketones, in which the oxygen is attached to the second carbon from one end of the chain. The group $-CO.CH_3$ forms an active end group, and this makes it possible for two molecules to link together in one long chain, giving a double spacing. The position of the CO group has otherwise no effect on the length of the spacing, but is shown to influence the intensity distribution in the X-ray spectrum; if, for example, the O is in the middle of the chain (di-*n*-ketones) the odd orders are strong and the even weak. Reproductions of photographs illustrate this point. H. N. A.

1557. *Further X-Ray Measurements on Long-Chain Compounds.* (*II. Hydrocarbons.*) **A. Müller** and **W. B. Saville.** (Chem. Soc., J. 127. pp. 599–603, March, 1925.)—The X-ray investigations of long-chain compounds by Müller [Abstract 756 (1924)], and by Müller and Shearer, are extended to normal hydrocarbons. It is shown that the absence of oxygen, which was present in the substances previously investigated, has no appreciable influence on the reflecting power for X-rays, so that the chain itself plays a predominating part in the phenomena. A table gives the observed long spacings d_1 and the side spacings d_2, d_3, etc.; d_1 has been measured for ten different hydrocarbons from $C_{17}H_{36}$ to $C_{35}H_{72}$. The increase per carbon atom was constant within the limits of experimental error, and was very nearly 1·3 Å.U. per carbon atom. This is larger than for other substances investigated, and than would be expected from the Müller-Shearer theory; the reason will be discussed in a separate paper. The C_{18} and C_{20} hydrocarbons form exceptions. At room-temperature the spacings did not agree with the above constant increase of length per carbon atom; at a higher temperature normal spacings were found for these substances, which have two different crystalline forms. The side spacings are almost independent of N, the number of carbon atoms; but the two strongest lines of the side spacing group show a slight shift away from the centre as N increases—*i.e.* d_2 and d_3 decrease. These two lines coincide very closely with those of the fatty acids, esters and alcohols. H. N. A.

1558. *The Shape of Polyatomic Polar Molecules. I and II.* **F. Hund.** (Zeits. f. Physik, 31. 1–4. pp. 81–106, and 32. 1. pp. 1–18, 1925.)—The investigation I is connected with the work of Born, Heisenberg and Kornfeld on the influence of the deformability of ions on optical and chemical constants [see Abstract 2178 (1924)]. The problem of molecular shape is treated as one of the stable equilibrium grouping of a system of points between which act electrical forces. The single ions which form the molecule are regarded as completely symmetrical in the free state, and the quantum theory has not been involved in the grouping problem. For a molecule of the H_2O and H_2S type, the shape demanded is an equilateral triangle, dimensions and energy being then in agreement with the empirically known properties. For the NH_3 molecule a tetrahedron with three equilateral faces is obtained, and the number of fundamental frequencies is then found to agree with the empirically known absorption spectrum. The observed absorption maxima can be expressed as combinations of the three fundamental frequencies 570 cm.$^{-1}$, 1700 cm.$^{-1}$, and 4500 cm.$^{-1}$. II deals with molecules which consist of a negative ion with hydrogen nuclei. By means of the bands of the hydrogen halides and the work of dissociation, the potential gradient is determined for the ions F^-, Cl^-, Br^-, from which conclusions are drawn for the O^{--}, S^{--}, Se^{--} and N^{---} ions. This permits an estimation of the shapes, sizes and energies of the following molecules and ions: $H_2Cl^{\cdot}$, $H_3Cl^{\cdot\cdot}$, HO', H_2O, $H_3O^{\cdot}$, H_2S, H_2Se, H_3N, NaOH, KOH. An appendix deals with the molecules of the alkali oxides.
H. H. Ho.

1559. *Remarks on the Theory of Quanta.* **G. Juvet.** (Arch. des Sciences, 7. pp. 5–18, Jan.–Feb., 1925.)—The author examines the quantising conditions proposed by Schwarzschild, Sommerfeld and

Epstein to determine the stationary trajectories concerned in the dynamics of the Bohr atom, attention being more especially paid to the unique character of the orbits. It is shown that if the Jacobian equation $H(q_i, \ldots q_n, \partial V/\partial q_i \ldots \partial V/\partial q_n) - \alpha_1 = 0$ relating to a system having n degrees of freedom, $q_i \ldots q_n$ being the Lagrangian coordinates, can be resolved by separation of the variables, the coordinates being variously chosen, then if the motion so derived is non-degenerate quasi-periodic it follows that whatever variables be chosen, the appropriate quantising conditions are always expressed by the equation $\oint p_i dq_i = K_i h$, where i has the values $1 \ldots n$, K_i represents a series of whole numbers and p_i is the moment corresponding to the coordinate q_i. J. S. G. T.

1560. *Electric Forces and Quanta.* **J. H. Jeans.** (Inst. Elec. Eng., J. 63. pp. 483–489, May, 1925. Nature, 115. pp. 361–368, March 7, 1925. Supplement. Engineer, 139. pp. 181–183, Feb. 13, 1925. Abstract.)—Sixteenth Kelvin Lecture. G. W. DE T.

1561. *Intrinsic Frequency of an Electron.* **L. de Broglie.** (Comptes Rendus, 180. pp. 498–500, Feb. 16, 1925.)—In connection with a theory of quanta, the author has supposed the existence of a periodic phenomenon in each electron accompanied by continuous radiation. This radiation is denoted by a function $\phi(r_0) \cos 2\pi\nu_0 t_0$. Considering planes of equal phase propagated normally to the z axis and in conformity with the equation $\frac{1}{c^2}\frac{\partial^2 A}{\partial t^2} = \Delta A$, it is possible to write as a necessary condition :

$$\frac{1}{c^2}\frac{\partial^2\phi}{\partial t^2} + \frac{4\pi i\nu}{c^2}\frac{\partial\phi}{\partial t} - \frac{4\pi^2\nu^2}{c^2}\phi = \Delta\phi - \frac{4\pi^2\nu^2}{V^2}\phi - \frac{4\pi i\nu}{V}\frac{\partial\phi}{\partial z}.$$

Separating the real and imaginary terms, it follows that $u = z - \frac{c^2}{V}t$ and $\Delta_0\phi + \frac{4\pi^2\nu_0{}^2}{c^2}\phi = 0$. Assuming spherical symmetry about an electron the form of the function $\phi(r_0)$ is $\frac{K}{r_0}\cos\left(\frac{2\pi\nu_0 r_0}{c} + \alpha_0\right)$ and

$$A_0 = \frac{K'}{r_0}\left\{\cos\left[2\pi\nu_0\left(t_0 + \frac{r_0}{c}\right) + \alpha_0\right] + \cos\left[2\pi\nu_0\left(t_0 - \frac{r_0}{c}\right) - \alpha_0\right]\right\}$$

which is equivalent to the disturbance due to two superimposed convergent and divergent waves. The frequency is numerically equal to $1{\cdot}2 \times 10^{20}$ per sec. and the wave-length to $2{\cdot}5 \times 10^{-10}$ cm. A. Wh.

1562. *The Interpretation of the Results of Bucherer's Experiments on e/m.* **T. Lewis.** (Roy. Soc., Proc. 107. pp. 544–560, March 2, 1925.)—The form of the trace of the rays emitted in Bucherer's experiment for the determination of e/m [see Abstract 912 (1909)] is deduced mathematically on the assumption that the Lorentz mass formula holds for very high velocities. The general character of the experimental trace appears to be much the same as that so deduced, assuming that electrons are emitted with velocities as great as 0·94 (or 0·98) times the velocity of light. These velocities are much greater than the highest velocities found by Ellis to be associated with electrons emitted from radium salts, but are well within the limits of velocities observed by Danysz. The author suggests the desirability, from the point of view of the theory of relativity, of further experiments by Bucherer's method, and of a more extensive and detailed investigation of the β-ray spectrum of radium. J. S. G. T.

1563. *A New Discussion of Bucherer's Experiment.* **U. Doi.** (Phil. Mag. 49. pp. 434–446, Feb., 1925.)—An examination of Bucherer's experimental values of e/m corresponding to different values of the velocity of the electron [Abstract 912 (1909)] indicates that these values are in much closer agreement with results calculated by means of the author's theory of relativity which excludes the Einsteinian relativity of time and space, than with results calculated by means of the Lorentz-Einstein formula. The author suggests that the most reliable value of e/m corresponding to small electronic velocities is derived from electrolytic and spectroscopic data, which give the value $1\cdot769 \times 10^7$ e.m.u. J. S. G. T.

1564. *À propos of Relativity.* **F. Prunier.** (Rev. Gén. d'Él. 17. pp. 207–213, Feb. 7, and pp. 247–251, Feb. 14, 1925.)—By the aid of Newtonian mechanics only, and without having recourse to the Principle of Relativity, the author deduces equations analogous to those derived by Einstein relating to the three crucial phenomena—*viz.* the deviation of a ray of light in a gravitational field, planetary perturbations, and the displacement of spectral lines in a gravitational field. Results deduced by means of Weyl's theory equally with those derived from Einstein's theory are deducible by strictly Newtonian mechanics in the manner suggested by the author. A crucial experiment resembling that suggested by Sagnac is proposed to settle the controversial question of the possible entrainment of ether by matter in motion. The author suggests that the law of constancy of the ratio of electrostatic intensity to electromagnetic intensity of current in the electromagnetic field is not conserved when the system of axes employed is in motion relative to a fixed system of axes. J. S. G. T.

1565. *À propos of Relativity.* **G. Fournier** and **F. Prunier.** (Rev. Gén. d'Él. 17. pp. 485–486, March 28, 1925.)—It is shown that the method of successive approximations applied to the solution of the equation of planetary motion derived by Prunier [see preceding Abstract] leads to a value of the displacement of the perihilion of Mercury which is only one-third of the observed value. Perihelion displacement in planetary motion and the deviation of stellar rays in the neighbourhood of matter can be accounted for if the velocity v at distance r is given by the equation $v^2 = c^2 + 4M/r + 6M^2/r^2c^2$. Prunier, in his reply, directs attention to the approximate character of the law of the constancy of areal velocities. J. S. G. T.

1566. *Relativity referred to a Flat Space-Time.* **C. K. V. Row.** (Nature, 115. pp. 261–262, Feb. 21, 1925.)—Defining the interval between contiguous point-events as $ds^2 = g_{\mu\nu}dx_\mu dx_\nu$, in which the $g_{\mu\nu}$ satisfy the necessary and sufficient condition for " flat " space-time, *viz.* $B^{\epsilon}_{\mu\nu\sigma} = 0$, the author shows briefly how a consistent formulation of the laws of mechanics, of gravitation, and of electromagnetism conforming to the general principle of relativity is possible, whilst retaining the concepts of inertia, force, invariability of mass and Galilean and Newtonian dynamics.

The theory avoids the necessity of formulating a space-time continuum "curved" by the existence of matter. J. S. G. T.

1567. *Relativity Theory of Spherical Mass Systems.* **Lémeray.** (Comptes Rendus, 180. pp. 909–912, March 23, 1925.)—The mass systems considered are those of constant mean density. A correction is made to an earlier paper and the final expressions deduced briefly compared with those obtained on the Newtonian system. It is shown that the period is the same. If a series of bodies be projected with different velocities perpendicular to the radius, on the Newtonian system, they will always lie in a plane. On the relativity theory these "isochronous surfaces" will be hyperboloids of revolution. Reference is made to the necessity of discriminating between observational and theoretical values in the sense in which the terms were used in a previous paper [Abstract 2012 (1924)]. A. Wh.

1568. *Discriminations between Past and Future.* **P. du Val.** (Phil. Mag. 49. pp. 379–390, Feb., 1925.)—In this paper the author supplements and develops an earlier one [Abstract 2204 (1924)] on the same subject. He argues that the consciousness of an observer is related to his past and his future in ways far more strikingly different than the mere geometry of the question would lead us to suppose. G. W. DE T.

1569. *Eddington's Natural Unit of the Field, and Possible Relations between it and the Universal Constants of Physics.* **J. Rice.** (Phil. Mag. 49. pp. 457–463, Feb., and pp. 1056–1057, May, 1925.)—On the basis of Eddington's Principle of Identification [see Abstract 1001 (1921)], and adopting his view that the law of gravitation in the form $G_{\mu\nu} = \lambda g_{\mu\nu}$ is a gauging equation which affords all the most important properties of a world of uniform curvature, it appears that the radius of curvature of the world should be the natural unit of length on which units employed in the theory of geometrical tensors should be based. The adoption of this unit might then lead to the discovery of natural units of physical quantities. Employing the length $\lambda^{-\frac{1}{2}}$ cm. as a gauge in a coordinate system in which the unit mesh has a width $\lambda^{-\frac{1}{2}}$ cm., and making the plausible assumption that in this gauge-system the matter-tensor and electromagnetic energy-tensor are expressed in the same unit, it is shown that $G^{\nu}_{\mu} - \frac{1}{2} g^{\nu}_{\mu}(G - 2) = F_{\mu\alpha}F^{\nu\alpha} - \frac{1}{4}g^{\nu}_{\mu}F_{\alpha\beta}F^{\alpha\beta}$. Transforming to a system in which the gauge is 1 cm., it follows that $F_{\lambda\alpha}F^{\mu\alpha} - \frac{1}{4}g^{\nu}_{\mu}F_{\alpha\beta}F^{\alpha\beta} = \lambda^{-1}[G'^{\nu}_{\mu} - \frac{1}{2}g'^{\nu}_{\mu}(G' - 2\lambda)]$, the accented symbols referring to the second system of coordinates. The right-hand side is equal to $- 8\pi k T'^{\nu}_{\mu}$, where T'^{ν}_{μ} is the matter-tensor, expressed in c.g.s. units, and k is the quotient of the astronomical constant by the square of the velocity of light. Hence the electromagnetic energy-tensor, E^{ν}_{μ}, is equal to $8\pi k\lambda^{-1}T'^{\nu}_{\mu}$. It is shown that the natural unit of the electrostatic field is $c\sqrt{(\lambda/2k)}$ e.s.u., and hence that the cosmic unit of electric charge ϵ is given by $\epsilon/R^2 = c\sqrt{\lambda/2k})$, R being the radius of curvature of the world. In the second note the value of R employed in the first paper is corrected, and attention directed to the fact that if R be given Silberstein's value—*viz.* $7{\cdot}2 \times 10^{12}$ astronomical units—and if the unit of action be taken as Planck's constant h, then the relation $r^2/R\rho = 6hc/e^2$, e being the electronic charge, r the electrical radius, and ρ the gravitational radius of the electron is very closely satisfied numerically, e, r and ρ being given the commonly accepted values. It is suggested that the pure number hc/e^2 may be contained in the metrical relations of the structure of the world. J. S. G. T.

1570. *The Curvature Radius of Space-Time.* **L. Silberstein.** (Roy. Astron. Soc., M.N. 85. pp. 285–290, Jan., 1925.)—A rejoinder to Lundmark [Abstract 42 (1925)]. It is pointed out that the results derived from O stars, R stars and spiral nebulæ are not unfavourable to the theory. The large dispersion in R, which Lundmark cannot explain by the uncertainty of the parallaxes in the case of the globular clusters, is shown to be due to the fact that an approximate formula only has been used. If the full formula for radial motions passing through the sun $D^2 = \frac{r^2}{R^2} + \frac{v_0^2}{c^2}$ is used, or the most general formula for any inertial motion which is reversed at a distance r_0 (perihelion) $D^2 = \left(1 - \frac{r_0^2}{r^2}\right)\left(\frac{r^2}{R^2} + \frac{v_0^2}{c^2}\right)$, the dispersion objected to will not occur. The correlation coefficient with its probable error is calculated between r and cD for twenty-one objects, and is found to be $0{\cdot}367 \pm 0{\cdot}127$, while if three objects are omitted the coefficient is $0{\cdot}747 \pm 0{\cdot}070$, which is quite a good correlation. The values of r_0 and v_0 for very distant objects cannot be obtained, but if it is assumed that all orbits are approximately rectilinear and inclined at random to the line of sight, it is valid to write $D^2 = \frac{1}{3}\left(\frac{r^2}{R^2} + \frac{\overline{v_0^2}}{c^2}\right)$. A closer approximation is probably obtained by considering the orbits to be slender, hyperbolically-shaped loops, in which case the expression to be used is $D^2 = \frac{2}{3}\left(\frac{r^2}{R^2} + \frac{\overline{v_0^2}}{c^2}\right)$. From these considerations it appears that the best value at present obtainable for the curvature radius is $7{\cdot}2 \times 10^{12}$ astronomical units. A. Wh.

1571. *The Problem of the Infinitely Weak Field in Einstein's Theory of Gravitation.* **K. Lanczos.** (Zeits. f. Physik, 31. 1–5. pp. 112–132, 1925.)—A gravitational field may be built up by a series of successive additions of an infinitely small distribution of matter to the existing distribution. The author investigates the effect of such an addition of an infinitely small quantity of matter upon a curved metric field. The differential equations of the modified field are determined and their solution derived by the introduction of a function termed by the author a "Green tensor," and defined as a tensor related to a fixed and a variable point in the field. The method of solution employed for the solution of tensorial differential equations is based upon certain tensorial integral equations closely related to Fredholm integral equations. J. S. G. T.

1572. *Gravitation and the Principle of Action and Reaction.* **G. Maneff.** (Zeits. f. Physik, 31. 10. pp. 786–802, 1925.)—Previous work by Poincaré, Abraham, Planck [see Abstract 412 (1909)], Hasenöhrl, and Einstein first receives attention. It is then argued that whereas gravitation has been the cause of the removal of the second postulate of the special theory of relativity—*viz.* the principle of the constancy of the velocity of light—the cosmological problem compels the first relativity postulate to be rejected. In the former case the problem was only decided by inclusion of the special relativity theory in the general, but in the latter it is necessary to replace the kinematic principle of relativity by a dynamical one, *viz.* the extended reaction principle. By the latter substitution not only have all the effects of the relativity theory been explained by the processes of classical mechanics, but also the classical conceptions of universal time, euclidean space and ether are well preserved. The paper is mathematical throughout. H. H. Ho.

1573. *On a Time Periodic World and a New Treatment of the Problem of Ether Radiation.* **K. Lanczos.** (Zeits. f. Physik, 32. 1. pp. 56–80, 1925.)—The solution of the wave equation in the Einstein cylinder world has been investigated and the closed character extended to the time axis. It follows that the ether acquires a material oscillation not unchanged with respect to radiation, but with a phase displacement and reinforcement of amplitude which depends on the wave-length. The reinforcement factor increases beyond limit when certain wave-lengths are approached, *viz.* the fundamental oscillations of the ether. These critical frequencies are conditioned by the spatial structure of the world and lie very close together. In spherical space they are equidistant. The results may be extended generally to worlds spatially closed and stationary in time, when space and time axes are perpendicular. A non-periodic world corresponds to the limiting case of a periodic world with an infinitely increasing period. Based on the resonance properties of the ether, the standpoint gained from radiation processes and the difference between radiating and non-radiating states differs in essential features from the classical presentation and corresponds with certain conclusions of the quantum theory. H. H. Ho.

1574. *On the Problem of Ether Radiation in a Spatially Closed World.* **K. Lanczos.** (Zeits. f. Physik, 32. 2. pp. 135–149, 1925.)—This paper is complementary to a previous publication [see preceding Abstract] in which an essential improvement was introduced by avoidance of time integration and fulfilment of the causality principle. Now time considerations are no longer considered and the theory entirely based on spatial enclosure, spatial functions being employed in the sense of the general integral equation theory. The connection between excitation shock and wave radiation is analysed generally and a new phenomenon derived which may possibly be accessible to experiment, *viz.* the presence of a detached converging wave in the vicinity of a luminous point. H. H. Ho.

METEOROLOGY AND GEO-PHYSICS.

1575. *On the Production of Cold and Warm Spells in the Atmosphere.* **F. M. Exner.** (Akad. Wiss. Wien., Ber. 133. 2a. No. 3–4. pp. 101–115, 1924.)—An important influence in meteorology is that due to two neighbouring masses of air at different temperatures. The relative movement of such masses may produce cold or warm spells. Calculations depend on whether the isotherms are perpendicular or nearly parallel to the wind direction. By calculating what acceleration of the masses of air can be expected perpendicular to the isotherms, the occurrence of warm or cold spells of weather can be accounted for. This problem is treated mathematically, and numerous examples are given. J. R.

1576. *The Correlation between Pressure and Temperature in the Upper Air, with a Suggested Explanation.* **W. H. Dines.** (Roy. Meteorolog. Soc., J. 51. pp. 31–36; Disc., 36–38, Jan., 1925.)—Correlation coefficients for successive heights up to 13 km. between the mean temperature and mean pressure for S.E. England show high values from 4 to 8 km. The values are also given of the regression equations obtained from the standard deviations at each height and these correlation coefficients. As adiabatic changes fail to account for the whole of the observed temperature change at any height for a given pressure change, part must be due to pressure changes produced by vertical motion. An illustration is given of the redistribution of temperature set up in the atmosphere when heat is applied at any given point and this applied to the movement of air at the 9 km. level from a depression to an anticyclone. In the *Discussion*, **N. Shaw** doubted the existence of the force required at 9 km., and suggested that thermal stratification might be of assistance in producing the thermal effects and explaining the dynamical effects. R. S. R.

1577. *The Influence of the Mean Atmospheric Temperature in Spring in North Iceland on the Mean Atmospheric Temperature of the following Winter in Europe.* **W. Wiese.** (Meteorolog. Zeits. 42. pp. 53–57, Feb., 1925.)—In investigating a possible connection between the ice conditions in the Greenland Sea in spring and the winter temperature in Europe the author took as an indicator of the ice conditions the mean temperature of the air in Grimsey from March to May. This was compared with the mean temperature of the following December and January in various European places by means of the correlation method for fifty-nine stations. The investigation was based on observations for the thirty-seven years from 1882 to 1919. The results are given in a table and an isocorrelation map which cannot be reproduced in a short abstract, and should be studied in the original paper. E. F.

1578. *Travelling Depressions.* **J. Letzmann.** (Meteorolog. Zeits. 42. pp. 41–52, Feb., 1925.)—For the study of the paths of air particles in a depression the author seeks to distinguish between the rotatory movement of each particle around the centre of the depression and the general forward movement of the whole system. The angle between these two directions will vary from point to point in the system. He subdivides the depression by a series of circles, and an integral diagram of the stream lines is built up, using a method similar to Sandström. The results obtained are then applied to the cases of whirlwinds and waterspouts, and the general movements in their different parts are discussed. The types with a funnel-shaped core and a cylindrical core are examined in detail, and the conditions giving rise to each are investigated. The development of lines of convergence and divergence are next treated, and these are applied to cases of depressions and anticyclones in both hemispheres. A series of diagrams illustrates the several patterns which the air movements in the general circulation may follow. It is shown, further, that these wind distributions hold for tropical cyclones, and the change in velocity from the centre outwards in different radial directions is examined. The conditions for regions of light winds at the centre and at the periphery are dealt with and the circumstances favourable for the development of each. For depressions in middle latitudes the wind circulation and air movements in the core, the cap, and at the boundary are discussed, and examples of weather charts are quoted which illustrate the different types. Owing to the difficulties on some occasions of demonstrating the presence of warm and cold fronts in a depression the author considers it better to use his types rather than those of Bjerknes. Lastly, the bearing of the work of Bjerknes, Hesselberg, Wenger, Exner, Kobayasi and Ryd on the author's results is discussed. R. S. R.

1579. *The Upper Air Circulation of the Atlantic Ocean.* **E. W. Barlow.** (Air Ministry, Meteorolog. Office, Prof. Notes, 3. No. 39 [18 pp.], 1925.)—Part I of this pamphlet gives a historical account of the various series of observations of upper wind currents and temperatures made over the Atlantic Ocean. Information was acquired mainly by means of kites and pilot balloons sent up from shipboard or from islands, but observations of cloud motion and the drift of volcanic dust are also referred to. Part II gives our present knowledge of the actual air circulations over the ocean and shows the relation of the trade winds, the counter-trades and the eastern equatorial current. Part III deals with the meteorological aspects of Atlantic flying, including the frequency of sea-fog and of the conditions which create " bumpiness." The best season and the most favourable heights for making flights to North and South America are discussed, and among the tables will be found one showing the times required under different conditions for making flights with machines capable of various air speeds. AUTHOR.

1580. *Photometric Observations on Clouds and Clear Skies.* **L. F. Richardson.** (Roy. Meteorolog. Soc., J. 51. pp. 7–21; Disc., 21–23, Jan., 1925.)—A description is given of an improved photometer used at Benson Observatory for measurements of the brightness of the sun or moon in cases of transparent clouds or skies and for uniformly glowing clouds or other bodies. The range of the instruments is 10^6 to 1. Measurements made on the moon at and near to sunrise and sunset indicate that considerable variations occur in the transparency of the sky, there being a distinct increase for green light during evening twilight. Measurements were made, further, of the brightness of the sun's limb at different altitudes for a clear sky, and later for the sun or moon seen through high, medium and low clouds. Where a corona was visible the size of the droplets was calculated, and from this the " equivalent rainfall " contained in the cloud [see Abstract 40 (1920)]. Next similar measurements were made on clouds which completely or almost completely hid the sun, and these are used to test the theories connecting the photometric measurements with the number and size of the cloud droplets. In the *Discussion* the importance of the results for work on the solar constant was brought out by **G. M. B. Dobson.** R. S. R.

1581. *Modern Atmospheric Conditions, with Special Reference to London.* **J. S. Owens.** (Roy. Soc. Arts, J. 73. pp. 434–453; Disc., 453–457, March 27, 1925.)—The methods used and the results obtained in the investigations of atmospheric conditions by the Advisory Committee on Atmospheric Pollution are briefly described. Thick smoke fogs in London are usually accompanied by thick water fogs in the surrounding country, but the temperature is usually higher in London. Thus the water fog in London is partially evaporated, but its place is taken by smoke, which cannot disperse rapidly owing to the accompanying light winds and inversions of temperature. The diurnal variation of the amount of suspended impurity is similar for ordinary and thick days. Under favourable conditions the smoke particles may be carried for hundreds of miles before settling, but probably the sulphur impurities are carried farther than the carbonaceous or insoluble dust. A. W. L.

1582. *Meteorology at the British Association for the Advancement of Science and the International Mathematic Congress.* **J. Patterson.** (Roy. Astron. Soc. Canada, J. 19. pp. 4–9, Jan.–Feb., 1925.)—A summary is given of papers dealing with meteorology which were read and discussed at the meetings in Toronto, August, 1924, and of work carried out while crossing the Atlantic by British meteorologists. R. S. R.

1583. *Tides in a Channel.* **J. Proudman.** (Phil. Mag. 49. pp. 465–475, Feb., 1925.)—The tidal dynamics of a channel of uniform longitudinal section but of varying depth from side to side is discussed. It is shown that Airy's conclusion that in such a channel the ridge of wave cannot stretch transversely to the channel is erroneous, and that his rule for the direction of rotation of tidal currents is valid over wider conditions than specified by Airy. The case of a channel of parabolic transverse section is treated in detail, and it is shown that the " narrow sea theory " of tides in gulfs, channels, etc., developed by Sterneck and Defant affords a high degree of accuracy provided the channel is not too wide or too shallow. The accuracy, however, decreases when the effect of the earth's rotation becomes important. J. S. G. T.

ASTRO-PHYSICS.

1584. *Line-Intensities in Stellar Spectra.* **D. H. Menzel.** (Harvard Coll. Obs. Circ. 258. [20 pp.], 1924.)—Measurements were made of the intensities of important lines due to twenty different kinds of atoms in the spectra of twenty typical giant stars, of type ranging from B8 to M3. The measurements give variation of line-intensity from star to star as well as the relative strengths of the lines in any given spectrum. The qualitative agreement with the theory of Fowler and Milne is excellent; the lines belonging to subordinate series reach maxima practically in the order of the ionising potentials of the respective elements. The ionisation potentials are estimated for the atoms Fe^+, Ti^+, Y^+, Se^+, and Si. The quantitative agreement is not as good. The observed maxima for stars of later spectral type occur at a much lower temperature than predicted. This, together with the unexplained behaviour of hydrogen in C stars, and the observed slow rise of a line to a maximum as temperature rises, show that the theory requires revision. A detailed comparison of ϵ-Indi and α-Tauri shows that the simple theory will account for the spectral differences between giant and dwarf stars. Except for the evidence of hydrogen, the C stars will probably be stars cooler and at a lower pressure than the giants. As the light of a star decreases, the emission lines appear in order of increasing ionisation potential. No element giving emission lines has an ionisation potential of less than 7·4 volts. S-type variables, and R and N stars, are probably cool, rare stars. A. C. M.

1585. *Absolute Magnitudes of Stars in the Pleiades: Remarks on the Investigation of Kienle and ten Bruggencate.* **W. Baade.** (Zeits. f. Physik,

31. 7–8. pp. 604–605, 1925.)—Kienle and ten Bruggencate have attempted to show that the colour-brightness diagram of the Pleiades indicates the existence of absorbing nebulosity in this cluster. [See Abstract 55 (1925).] Their work, however, includes a number of stars which do not belong to the Pleiades, but lie beyond it, as shown by Trumpler [Abstract 497 (1922)] and Hertzsprung (Effective Wave-lengths of Stars in the Pleiades, Mémoirs de l'Acad. Roy. des Sciences de Danemark (8) 4, 4.). Hertzsprung has further shown that all the stars which are certainly members of the cluster fit perfectly into the normal colour-brightness diagram, and therefore there is no ground for assuming nebulous absorption. M. A. E.

1586. *Absolute Magnitudes of Stars in the Pleiades.* **H. Kienle.** (Zeits. f. Physik, 31. 7–8. p. 605, 1925.)—Baade's criticism proves that our hypothesis is not applicable to the Pleiades. We were unable to consult directly Trumpler's work, and we have not seen the criticism of Hertzsprung. [See preceding Abstract.] M. A. E.

1587. *Condensations in Spiral Nebulæ.* **J. H. Reynolds.** (Roy. Astron. Soc., M.N. 85. pp. 142–147, Dec., 1924.)—The author finds that spirals vary greatly in the matter contained, both in nuclei and arms, and gives M101 and M33 as examples. He divides those of a similar degree of condensation into two classes, the massive and the filamentous, the distinction applying to all degrees of condensation. He inquires whether the mechanism of formation is the same for both classes. Sometimes both types of condensation are present in the same spiral as in N.G.C. 628 and M101. Sometimes the angular spacings between the condensations are regular, sometimes irregular, but almost always they increase outwards. He considers the evolution of the nebular condensations into stars of ascending temperature. It is to be expected that the condensations in the filament would gradually concentrate into M-type giants of short effective wave-lengths, the stars in the outer spirals being more advanced than the condensations near the nucleus, so that there should be an increase of photographic magnitude of the stellar condensations from the nuclear regions outwards. He finds many instances in support, notably M33, in whose outskirts is a type of nebulosity associated only with B stars. His general conclusion is that though M31 and M33 may be comparable in dimensions with the Galaxy, most spirals are relatively quite insignificant. A. S. D. M.

1588. *Gravitational Forces in Spiral Nebulæ.* **E. W. Brown.** (Astrophys. J. 61. pp. 97–114, March, 1925.)—In a previous paper [see Abstract 804 (1924)] Jeans assumed that the motions in general are along equiangular spirals outward, and concluded that the forces necessary to produce them are non-central and that the laws of their variation cannot arise from any known source. This paper is an attempt to explain the internal motions by gravitational action alone. An analysis is made of the components of motion in seven spirals measured by van Maanen, and it is shown that the average velocities, angular and radial, at different distances can be explained on the assumption that the nebula consists of a nucleus of concentrated matter with particles distributed round it which are describing orbits under the attraction of all the matter in the nebula, but are so widely scattered that collisions are rare; further, that the orbits are of such a character that their envelopes are the arms of the spiral, these becoming visible because of the concentration of matter on the envelope. M. A. E.

1589. *Ozone as Absorbing Material for Radiation.* **C. Fabry.** (Journ. Math. Phys., Mass. Inst. of Technology, 4. pp. 1–20, Jan., 1925.)—A study of the ultra-violet solar spectrum. The author reviews the work of Cornu, Hartley, and of Méthe and Lehmann, who deny that the sun emits radiations below 2900 Å. The present investigation depends on quantitative data, got by photographic photometry of the absorption spectrum of ozone and its comparison with the absorption curve in the atmosphere. A figure is given for the values of a (the absorption constant) showing a pronounced maximum at about $\lambda = 2550$, this wide absorption band coinciding with the spectrum region where ozone (O_3) is decomposed into oxygen (O_2). The spectrograph for the end of the solar spectrum is described, and the measurements of ratios of intensities of a particular wave-length at different hours of the day are made photographically by the Bouguer-Langley method. It is concluded that it is actually ozone which produces the absorption in the ultra-violet in our atmosphere, and that the total thickness of this gas is about 3 mm., but small variations, without relation to meteorological conditions, are found from day to day. The ozone layer is chiefly at great heights, above 50 km., and the oxygen is transformed into ozone by radiations below 1900λ, which may be solar, since there is no abrupt fall of intensity in the region studied. In the region 2200–2000λ strong absorption, due to ammonia in the lower atmosphere, is found. Ozone absorption bands were looked for in the yellow, the red, and the infra-red regions, but were not found. The author suggests means for determining the height of the ozone layer more exactly. A. S. D. M.

1590. *Long-Period Variable W Hydræ.* **I. Yamamoto** and **L. Campbell.** (Harvard Coll. Obs. Circ. 270. [7 pp.], 1924.)—The catalogue range of 1·3 magnitudes has been challenged by Markwick and by Merrill as being abnormally small for a variable of about 380 days' period. The authors investigated 800 plates, covering period 1900–1924, at Harvard, and made 717 definite estimates of its brightness. Tables are given of comparison stars, of the individual estimates of brightness, and figures of ten-day intervals and of the mean light curve. Deviations are plotted from the uniform period represented by the formula $M = 2395345 + 385^d6.E$, $M - m = 198^d$, and from the same formula with the additional term $+ 100^d \sin 7°2E$. The range is photographically almost 3 magnitudes, and not 1·3 as catalogued, and the star is therefore not abnormal. The spectrum is Class Mc, having $H\gamma$ and $H\delta$ bright, with $H\delta$ ten times as bright as $H\gamma$. A. S. D. M.

1591. *Relation of Hydrogen Line-Widths to Absolute Magnitude for Class A Stars.* **Priscilla Fairfield.** (Harvard Coll. Obs. Circ. 264. [8 pp.], 1924.)—Over three hundred B- and early A-type stars have been examined and classified, according to width of the $H\gamma$ and $H\delta$ lines in their spectra, in order to test the theory that absolute magnitudes are correlated with width of the hydrogen lines. The Harvard estimate of line-width and the Mt. Wilson description of line-character are in close agreement, "sharp" lines corresponding with the narrower widths, "nebulous" lines to the broader; but there is no evidence of correlation

between line-width and absolute magnitude, and the apparent correlation found at Mt. Wilson of line-character with absolute magnitude appears to arise mainly from systematic differences in the classifications of Adams and Joy and of the Henry Draper catalogue. A definite correlation of line-character with reduced proper motion does appear when the averages of large numbers of stars are considered, and this may indicate dependence of line-character on linear speed rather than on intrinsic brightness.
M. A. E.

1592. *Statistical Study of the Brighter Class M Stars.* **W. J. Luyten.** (Harvard Coll. Obs. Circ. 273. [10 pp.], 1924.)—Giant stars of Class M are a homogeneous group well adapted for statistical treatment, being all much alike in spectral characteristics and the only type in which giants and dwarfs are completely separated, no star of intermediate brightness being known over a range of at least five magnitudes. From a discussion of the radial velocities and proper motions of 180 bright M-type stars, their mean absolute magnitude is determined as −0·8. Van Rhijn, whose paper on the same problem has meantime been published in the *Seeliger Festschrift*, finds that the frequencies of absolute magnitudes increase up to × 0·5, but this discrepancy is evidently due to the widely different material used. Van Rhijn includes all known M stars down to ninth magnitude; he has proper motions for many of these, but taken from statistically heterogeneous catalogues, and radial velocities are available for a few of the brighter stars only. Probably his values are systematically too faint and the writer's systematically too bright. A probable mean value of − 0·5 absolute magnitude is suggested. M. A. E.

1593. *Proper Motion of Star-Cluster M*35. **W. M. Smart.** (Roy. Astron. Soc., M.N. 85. pp. 257–267, Jan., 1925.)—Comparing recent photographs of this large open circular cluster with some excellent plates taken over twenty years ago by A. R. Hinks, a proper motion has been found, in seconds per century, of 0″·2 parallel to the equator and − 1″·0 in declination. M. A. E.

1594. *New Method for Determining Positions and Proper Motions of Stars from a Great Number of Catalogues.* **J. E. de V. van Steenwijk.** (Roy. Astron. Soc., M.N. 85. pp. 267–270, Jan., 1925.)—A rapid and simple graphical method is described, which saves the enormous amount of labour required by the method of least squares without involving any considerable loss of accuracy, and takes into account the different weights to be ascribed to the catalogue places. M. A. E.

1595. *Investigations of Proper Motion. 11th Paper. Messier* 13. **A. van Maanen.** (Mt. Wilson Observat. Contrib. No. 284. Astrophys. J. 61. pp. 130–136, March, 1925.)—The discovery of internal motions in spiral nebulæ was evidence against the belief in their enormous distances. An attempt has now been made to discover motions in the globular cluster of Hercules, M13. Two pairs of photographs taken with the Mt. Wilson 60-inch reflector, at intervals of eleven and nine years respectively, were studied, 50 comparison stars and 62 believed to belong to the cluster being selected for measurement. The results are shown in a table and a diagram, and are so small that a considerably longer interval will evidently be needed to detect any possible motion. This negative result confirms the great distances ascribed by

Shapley to globular clusters, the parallax for M13 found by him being 0″·00009; and it also confirms the motions found for spirals, since these cannot be due to the 60-inch reflector or the measuring instrument.

M. A. E.

1596. *Determination of Stellar Radial Velocities.* **M. Hamy.** (Comptes Rendus, 180. pp. 345–351, Feb. 2, 1925.)—The author reviews pressure, Zeeman, Stark, and other effects on radial velocities, and especially the gravitation effect predicted by Einstein. He points out that Fabry and Buisson in 1909 had studied by means of the interferometer the deviations in position of certain solar lines which were then attributed to pressure (though some facts were irreconcilable with this), but in 1921, on rediscussing their old measures, they found that the displacements of iron lines in the sun with respect to terrestrial arc lines in vacuum gave the Einstein displacement exactly. More lately it has also been shown that pressure in the reversing layers of the sun, Arcturus, and Procyon are but a small fraction of an atmosphere. Another disturbing cause found by Michelson was that many lines were complex, and that the positions of these complex lines shifted according to the method of exciting them, or temperature, or the purity of the metallic vapour, taking as an example the line λ5086 of cadmium. Fabry and Buisson have shown that iron lines form two groups: those that broaden unsymmetrically towards the red or the violet, and those that broaden symmetrically. Measurements of the displacements of iron lines at the centre of the sun's disc on spectrograms of great dispersion, as compared with the corresponding lines in a vacuum, also give rise to two categories: those that correspond exactly to the Einstein effect and those that do not. The former lines in the sun, when compared by Hartmann's method with the corresponding stellar lines, give the maximum of exactness.

A. S. D. M.

1597. *Study of Action of Resisting Medium. Application to Formation of Planetary Orbits.* **A. Véronnet.** (Bull. Astronomique, 4. 4. Ser. 2. pp. 351–394, 1924.)—The author considers the resistance as produced by encounters with particles absorbed by the star's atmosphere, and variation of the star's mass as introducing a parameter, by means of which is determined the variations of all the other elements of the orbit. The problem may be completely resolved, in particular in the classic case where the density of the medium varies inversely as the square of the distance. At each instant it is possible to compute the major axis and eccentricity of an orbit, the number of revolutions accomplished, the length of time passed, etc., as a function of the density of the medium only, thus obtaining the conditions of formation for the planets, the evolution of their orbits, their movements of rotation, all under the action of attraction by the elements of the medium alone. The treatment is chiefly mathematical, but he deduces that the major axis of an orbit always diminishes through the resistant action; that the eccentricity of an elliptic orbit does not vary if the resistance is proportional to the speed and independent of the distance, or if it is inverse as the distance and independent of the speed; that a parabolic orbit tends to become elliptic; that the eccentricity of an orbit varies in the inverse ratio of the cube of the star's mass. He contends that it is possible to explain qualitatively and quantitatively the formation of sun and planets, and their rotations in the primitive nebular medium, by the action alone of the centres of attraction in this medium—centres at first quite feeble, which have progressively developed the sun and stars; and that "it is sufficient to have one atom in excess, at a point in a homogeneous medium, to constitute a centre of attraction which will form a star."

A. S. D. M.

1598. *Bright Halos observed on Lunar Surface.* **Jarry-Desloges.** (Comptes Rendus, 180. p. 573, Feb. 23, 1925.)—The author states that the diameters of small bright halos surrounding certain lunar craters were systematically measured at Sétif, in 1922, by G. Fournier, in such manner as to throw into relief any changes in them taking place in the course of a lunation, and that the measurements have shown the existence of such variations to a considerable extent. A further extended series of observations are proposed, as they may be expected to throw some light on the nature of the moon's surface. G. W. DE T.

1599. *The Mass-Luminosity Law.* **J. H. Jeans.** (Roy. Astron. Soc., M.N. 85. pp. 196–211, Jan., 1925.)—Eddington's investigations have been generalised by the additional provision that the ratio of gas-pressure to radiation pressure at every point need not be constant. The paper is largely mathematical, but it is concluded that a definite mass-luminosity law cannot be sustained. Instead of the single mass-luminosity curve given by Eddington, there are found to exist an infinite number of these curves, the one followed being dependent on the mode of evolution of the star. In the light of the results different theories of star development are considered. If the mass remains constant throughout the life, red stars would be approaching the point of invisibility over the whole mass range, and no explanation of the separation into giants and dwarfs is afforded. If the star radiates at the expense of mass so that E/M is a constant, the surface temperature will increase, again contrary to observation. If a star is composed of two kinds of matter, one breaking down with the emission of energy, the other not (for any number of kinds or degrees of matter this is valid also), the star would become visible at a definite point, increase in surface temperature to a point and then decrease. At the same time the density would increase steadily except at the end of the life, when a decrease might appear. On these lines it seems possible to explain all the facts of the giant-dwarf hypothesis.

A. Wh.

1600. *Legendre's Theorem on Determination of Cometary Orbits.* **T. Banachiewicz.** (Acad. Polonaise des Sci. et des Lettres, Cracovie, Bull. No. 1. 2a. pp. 13–19, Jan.–Feb., 1924.)—The author shows that Legendre's theorem (that the two equations which give parabolic observations from three observations of a comet can have only one suitable root) is not incompatible with Oppolzer's discovery that there is a triple solution in Olbers' method. In exceptional cases this method is not directly applicable, since it is not permissible to neglect the unknown quantity m, which is become of the first order in the fundamental equation $\rho_3 = M\rho_1 + m$. Under certain conditions, m remaining a small quantity of the second order, Olbers' method continues in force, and gives Oppolzer's three solutions. If the comet moves in the ecliptic, and if the sine of its apparent distance from the sun at the times of observation are small quantities of the first order, and if the equations of Olbers' method admit a triple solution, then the author shows that in these conditions there are three systems of parabolic elements, representing not only the extreme observations, but also the mean place. He gives an imaginary and numerical example. A. S. D. M.

1601. *Relativity Relation between Mass and Energy and Stellar Evolution.* **E. Condon.** (Nat. Acad. Sci., Proc. 11. pp. 125–130, Feb., 1925.)—The relativity relation between energy and mass is $\Delta E = c^2 \Delta m$. Combining this with Stefan's law, it is shown that the interval of time corresponding to an interval of mass for a star of radius r and temperature T will be $dt = c^2 dm/4\pi\sigma r^2 T^4$. If the time be expressed in years and the stellar radii and masses in terms of those of the sun, this expression becomes $dt = 1{\cdot}63 \times 10^{28} dM/R^2 T^4$. Data collected by Seares on the mean masses and temperatures of stars on the dwarf line of evolution are taken. By trapezoidal integration a time scale for these stars is then constructed on the basis of the equation obtained. Shapley and Cannon have given a rough estimate of the relative number of dwarf star of the different classes, and, if the assumption of a uniform and steady distribution can be allowed, approximate agreement with the time scale found is obtained. A. Wh.

1602. *Calculation of Mean Absolute Magnitudes from Apparent Magnitudes, Proper Motions and Linear Radial Velocities.* **W. J. Luyten.** (Nat. Acad. Sci., Proc. 11. pp. 130–133, Feb., 1925.)—The assumptions made are a Maxwellian distribution of velocities and a normal error function for the absolute magnitudes. A mathematical analysis is given, but it is pointed out that there may still remain systematic sources of error, such as a dependency of luminosity on speed and the varying effect of errors of observation of different stars, when they are all reduced to the same absolute magnitude. A. Wh.

1603. *Mass Ratios in Double Stars.* **G. Shajn.** (Roy. Astron. Soc., M.N. 85. pp. 245–252, March, 1925.)—The mass ratios for double stars can be calculated from the theory of radiative equilibrium, and the differences of spectral type between the components agrees well with theory. In conjunction with the observed distributions of spectral class between the components of binaries, it appears that Russell's diagram really represents the course of evolution of a single star. The increase of the mass ratio for double stars arranged according to the spectral class of the primary does not allow any conclusions to be drawn as to the decrease of mass with age. A. Wh.

1604. *Spectrophotometric Measurements of the Effective Temperatures of Stars.* **R. A. Sampson.** (Roy. Astron. Soc., M.N. 85. pp. 212–245, March, 1925.)—The density of spectrum plates prepared under standard conditions is measured with the Koch microphotometer. The spectrum of Polaris is recorded on each plate as the standard of reference. The intensity, J, of the light is assumed to be connected with the density, Δ, and the exposure time, T, by the general relation $\log (J/J_0) = a\Delta + bT + \frac{1}{2}c\Delta^2 + d\Delta T + \frac{1}{2}eT^2 + \ldots$ The coefficients a, b, c, etc., are functions of the wave-lengths only. It is then shown that the cross coefficients d, etc., are negligible for the range of densities considered. Finally the equation is used: $\log (J_\lambda/J_\lambda') = a(\Delta_\lambda - \Delta_\lambda') + N$, and the quantities are plotted and the gradient determined. The gradient is usually nearly independent of wave-length, and so a whole series of readings can be combined. Also any notable abnormality shows up as a variable gradient. From the gradient the effective temperature is obtained. The results for 64 stars are tabulated and a correction to the gradient due to a zenith distance effect allowed for. Graphs are then shown exhibiting the relation between the gradient and the Mt. Wilson classification, the spectral class and the temperature, and the gradient and Hertzsprung's colour indices. A. Wh.

1605. *Circulating Currents in Rotating Stars.* **A. S. Eddington.** (Observatory, 48. pp. 73–75, March, 1925.)—H. v. Zeipel [Abstract 49 (1925)] has derived an expression for the rate of liberation of energy at any point in the interior of a rotating star which behaves as a rigid body. The expression is $\epsilon = C\,(1 - \omega^2/2\pi G\rho)$, where G is the constant of gravitation, ρ the density at the point, and C a constant for the star. This is independent of the mechanism of equilibrium in the star so long as the material is uniform in kind throughout. It appears impossible that this can express the actual rate of evolution of energy in a star, and it is more to the point to consider what will happen if von Zeipel's condition is not satisfied. The temperature on a level surface will no longer be equal at the equator and the poles; a pressure gradient will ensue and circulation of the material of the star to the limit imposed by the viscosity. It seems that the flow will be in opposite directions at deep and high levels in the star. The type of motion that will be set up is that which is observed, but hitherto it has been difficult to imagine how the relative motion can be maintained against the viscous losses. A. Wh.

1606. *Cosmogonic Time-Scale and Binary Stars.* **W. M. Smart.** (Roy. Astron. Soc., M.N. 85. pp. 423–433, March, 1925.)—In November, 1924, Jeans discussed several cosmogonic problems [Abstract 1025 (1925)] on the basis of a time-scale of 7×10^{12} years, this being derived by developing Eddington's theory of a secular decrease of stellar mass associated with radiation of energy. Three methods are here described of determining the time-scale, and Jeans' formula is adopted. It is shown from observational evidence of binary star-systems that the mass-ratio increases with advancing age, and thus the theory is corroborated, for the more massive component should radiate away its mass proportionately more rapidly than the less massive. It appears further that, given originally a sufficiently massive spectroscopic binary, the time-scale is ample to allow development into a visual binary with a period of the usual magnitude. M. A. E.

1607. *The Colour Variation of Amplitude in Variable Stars.* **la Rosa.** (Comptes Rendus, 180. pp. 912–914, March 23, 1925.)—The colour variation of the amplitude in certain variable stars can be most easily explained by differing spectral distributions in the components of which they are supposed to be composed. Since the temperatures of the components will usually differ, this will be the general rule. It is contended that this constitutes distinct support for the ballistic theory of variables put forward by the author. A. Wh.

1608. *Spectrum of Comet's Tails.* **F. Baldet.** (Comptes Rendus, 180. pp. 820–822, March 16, 1925.)—This spectrum, obtained by the electronic bombardment of carbon monoxide at a pressure of 10^{-4} mm., has been more completely studied with the spectro-heliograph at Meudon. A table is given of measurements on seven new bands in addition to three previously given. The lines of each band agree with Heurlinger's formula:

$$Q(m) - P(m) = R(m + 1) - Q(m + 1)$$

when m is small. Two bands follow the combination laws:

$$R_1(m) - Q_1(m) = R_2(m) - Q_2(m)$$
$$Q_1'(m) - P_1(m) = Q_2'(m) - P_2(m).$$

The other bands are more complicated. Twenty-three bands were observed in the tail of comet Morehouse by Baume-Pluvinel and the author, but 37 have now been observed by the present method between $\lambda = 3080$ and $\lambda = 6500$, and the structure of 27 of these has been revealed by high dispersion. F. S.

1609. *Mean Colour-Index of Stars of Different Apparent Magnitudes.* **F. H. Seares.** (Mt. Wilson Observat. Contrib., No. 287. Astrophys. J. 61. pp. 114–129, March, 1925.)—The increasing redness with decreasing brightness of stars in general, determined from several star-catalogues, is here shown by a curve; and another curve shows the increasing redness with increasing distance from the Galaxy, proving a remarkable concentration of blue stars in the Galaxy. A practical method is suggested for transforming visual magnitudes into photographic, and *vice versa*, which is an important procedure in statistical research. M. A. E.

1610. *Dissociative Equilibrium in an External Field of Force.* **E. A. Milne.** (Cambridge Phil. Soc., Proc. 22. pp. 493–509, March, 1925.)—The conditions of dissociative equilibrium in an external gravitational field, given by W. Gibbs, are as follows: If the state of a system is such that it is in (mechanical and thermodynamic) equilibrium when the constituents are taken to be independent, and if a condition of dissociative equilibrium is satisfied at one point, then the same condition is satisfied at all points, and the state is one of equilibrium if the constituents are actually capable of dissociating. In particular, the constituents of a column of dissociating gas under gravity settle out according to Dalton's law; if the condition of dissociative equilibrium is satisfied at one height, it is satisfied at all heights. It is shown that the above result remains unaffected when the conditions of equilibrium are generalised so as to take account of external electric fields and of the possibility of the products of dissociation being charged. Application of the theory to the equilibrium of an ionised gas such as a stellar atmosphere under gravity shows that, whatever the charge on a star, the tendency of the light electrons to diffuse away from the heavy ions is almost entirely perverted by the electrostatic forces between them, the result being the production of a field in the interior capable of supporting one-half of the weight of the positive ions. For the purposes of this statement the "interior" may be taken to commence at a pressure of 10^{-24} atmos.; it is only above the level corresponding with 10^{-34} atmos. that electrons and ions separate out according to Dalton's law. It is also found that an external applied field of the order 40,000 volt-cm.$^{-1}$ cannot give rise to potential differences exceeding about 1 volt under the conditions of a typical stellar atmosphere. T. H. P.

LIGHT.

1611. *Remarks on Complementary Colours.* **H. Schulz.** (Zeits. f. Physik, 32. 3. pp. 173–179, 1925.)—In endeavouring to represent the primary sensations as a function of wave-length, Aigner considered the receptive apparatus of the primary colours as resonators and calculated fundamental wave-length and damping. Between the wave-lengths of complementary colours the author establishes a relation having only two constants, one of which admits of a physiological interpretation. An attempt is thus made to arrive at an equation for the primary sensations which shall lead to further conclusions. The treatment is mathematical. E. F.

1612. *Absorption of Light in Optically Non-homogeneous Media.* **G. I. Pokrowski.** (Zeits. f. Physik, 31. 1–4. pp. 14–23, and 31. 7–8. pp. 514–522, 1925.)—The light-absorbing power of various thicknesses of milk-glass was determined. The intensity of the transmitted light was measured by a König-Martens spectrophotometer. It was found that Beer's law was fulfilled by optically non-homogeneous media if the layer is of sufficient thickness or if the incident light is diffused. The variations from the law mentioned above, with thin layers, is explained by the presence of spaces in the absorbing layer. This explanation holds also for thin layers of gold and copper made by kathode splashing, and is in agreement with the properties of free electrons in such layers. If an optically non-homogeneous body is coloured by a pigment, the intensity of the transmitted and the diffused light depends upon the concentration of the pigment. This dependence follows as a consequence of Beer's law, if the effects of spaces and of surface reflection are excluded. Further experiments were made with milk diluted with water, with indian ink diluted with water, and yolk of egg dissolved in water. The conclusions drawn from all the results are: (1) Light which has passed through an optically non-homogeneous body consists of two parts, one which has passed unchanged through the spaces, and the other which has passed through the absorbing and scattering elements in the medium. (2) The intensity of the transmitted light is the sum of these two portions. Equations can be deduced showing the dependence of the intensity of the transmitted light on the thickness of the layer and the concentration of the light-absorbing material. (3) These formulæ are confirmed by experimental results. F. J. B.

1613. *Reflection from Matt Surfaces.* **H. Schulz.** (Zeits. f. Physik, 31. 7–8. pp. 496–506, 1925.)—Gives the results of measurements of the reflection factors of various surfaces, plaster, opal glass depolished, filter paper, writing paper, and ribbed material. The values at various angles of incidence and of reflection are exhibited in the form of curves. It is shown that the formulæ proposed for semi-diffuse reflection do not express the results obtained. J. W. T. W.

1614. *On Kinematics.* **C. L. R. E. Menges.** (Phil. Mag. 49. pp. 579–583, March, 1925.)—This paper concerns the modern views related to electromagnetism applied to Fizeau's water-tube experiment and the formula $c/\nu + u(1 - 1/\nu^2)$, where c is the velocity of light *in vacuo*, ν the refractive index of water, and u the velocity of flow relative to the earth. This formula for flowing water has been very accurately confirmed indirectly by Zeeman's experiments on Fizeau's effect in moving solid transparent substances, and the present investigation concerns Fizeau's effect in moving transparent solids, three exactly defined cases being considered: (1) The source of light and glass cylinder at rest; (2) without material movement as in (1), but with the frequency change on the Doppler-effect; (3) the glass moving away from the source. The kinematic laws are shown to be confirmed and certain difficulties removed. H. H. Ho.

1615. *Relative Brightness of Scintillations.* **E. Kara-Michailova** and **H. Pettersson.** (Akad. Wiss. Wien, Ber. 133. 2a. No. 5–6. pp. 163–168, 1925.)—A method is described for the measurement of the relative brightness of scintillations. By means of this method scintillations produced by hydrogen nuclei (H particles) when compared with those produced by the α-particles from polonium have a relative brightness of 1 to 2·7. Further observations were made on the diminution of brightness of the scintillations produced by α-particles towards the end of their range. A. B. W.

1616. *Visual Acuity and Colour.* **M. Luckiesh** and **F. K. Moss.** (Optical Soc. America, J. and Rev. Sci. Inst. 10. pp. 275–281, March, 1925.)—Measurements of acuity were made with an Ives-Cobb test-object under illuminations provided by a tungsten lamp screened with bichromate solutions of various concentrations. It was found that, although the filter of maximum concentration reduced the field brightness to less than 50 % of the unscreened value, the visual acuity was practically unaltered, *i.e.* over the range of brightness from 0·2 to 20 millilamberts, the shortening of the spectrum at the blue end, due to the interposition of the yellow filter, increased the visual acuity to such an extent as to compensate for the loss of acuity that would otherwise have occurred owing to the halving of the field brightness. J. W. T. W.

1617. *Recurrence and Decay of After-Images.* **Winifred J. Smith.** (Roy. Soc. Edinburgh, Proc. 44. 3. pp. 211–217, 1923–1924.)—The law of fluctuation of after-images is found to be represented by the sum of three simple expressions of similar form, one for each of the three primary colour sensations. The form of expression found is

$$x = Ae^{-pt} + Be^{-pt} \cos \theta t + Ce^{-pt} \sin \theta t.$$

In consequence it is concluded that the eye mechanism may be represented either by an electrical or by an elastic analogy. J. W. T. W.

1618. *An Incandescent Lamp with Quartz Window.* **D. C. Stockbarger.** (Optical Soc. of America, J. and Rev. Sci. Inst. 9. pp. 337–339, Sept., 1924.)—There is a demand for a source of ultra-violet energy with spectrum continuous throughout the range of the ordinary quartz spectrograph. The quartz incandescent lamp is convenient, but the cost is high, and the services of an experienced quartz blower are required

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whenever repairs have to be made. G. Gelhoff has described a glass incandescent lamp having a quartz window cemented to the end of a tube. This method has advantages, but it is better to avoid the use of cement. The author accordingly describes a lamp using a 6-in. tube with a graded lime glass to quartz joint, on the end of which is sealed a ground and polished plane fused quartz window. The tube is sealed on the side of a 6·6-amp. series type nitrogen-filled tungsten lamp having twice the usual length of filament. This filament is overrun, but a life of approx. 100 hours is expected. The advantages of the lamp lie in its permanence, portability and ease of repair. The tube can be sealed on to any standard lamp having the proper shape and size of filament, so that special construction is unnecessary. J. S. D.

1619. *Monochromatic Illuminator for Infra-red and Ultra-violet.* **G. Athanasiu.** (Rev. d'Optique, 4. pp. 65–81, Feb., 1925.)—Describes an instrument in which the dispersing system consists of two semi-prisms of quartz, one right-handed and one left-handed, the angle of each semi-prism being 30°. One half of the system remains fixed, while the other is moved to obtain illumination of different frequencies. The instrument gives a high illumination in the ultra-violet. In a supplementary note a description is given of a device for avoiding any adjustment other than a simple revolution of the collimator or telescope about the vertical axis of the dispersing system, in order to bring the image of the collimator slit at the telescope slit for every frequency. J. W. T. W.

1620. *A Recording Camera taking Short Lengths of Film.* **J. S. G. Thomas** and **E. Simeon.** (Journ. Sci. Instruments, 2. pp. 218–221, April, 1925.)—A compact form of recording camera of dimensions 3 × 2½ × 4 in., capable of taking lengths of film as small as 1 ft., is described. The camera is driven by a 1/50 h.p. motor through a worm gear. The film is drawn steadily past the slit and a time record is produced on the film by means of a vibrating pointer attached to a spring support, the pointer obscuring the slit at regular intervals of about ⅛ sec. AUTHORS.

1621. *A Multi-Lens Automatic Micro-Camera.* **A. J. Dalladay, J. P. Anderson** and **F. F. S. Bryson.** (Journ. Sci. Instruments, 2. pp. 209–218, April, 1925.)—A description is given of an automatic film camera which has been used for obtaining photographic records of the slow growth of crystals in small specimens of glass exposed to certain temperature conditions. The camera is fitted with five 3-in. microscope lenses, by means of which photographs are obtained simultaneously of five different specimens, each supported by a thermocouple in a small platinum-wound tube furnace. Details are given of the mechanism provided for automatically opening the shutter at specified intervals and closing it after a predetermined length of exposure and for the movement of the film. The method of illumination adopted is such that the degree of devitrification occurring in different specimens is easily determined by comparing the photographs obtained. AUTHORS.

1622. *Photographic Plates for the Detection of Mass Rays.* **F. W. Aston.** (Cambridge Phil. Soc., Proc. 22. pp. 548–554, March, 1925.)—

The sensitivity of photographic plates to mass rays bears practically no relation whatever to their sensitivity to light. A short account is given of tests on the relative merits of different brands of plates since the first experiments on positive ray analysis. The process of improving the qualities of plates by schumannising is discussed, and details are given of the process found likely to give the best results. Success cannot be guaranteed even with the most careful manipulation, but if achieved yields plates of outstanding value for use in such methods of analysis as the mass-spectrograph. AUTHOR.

1623. *The Transparency of Glass for the Infra-red.* **F. Llana.** (Comptes Rendus, 180. pp. 578–579, Feb. 23, 1925.)—A note on the search for a piece of glass suitable for spectrographic work for long wave-lengths in the examination of the solar spectrum. The work was done at Utrecht with Moll's infra-red spectrograph. Eighteen pieces of flint and crown glass were examined, and all proved opaque to very long wave-lengths if above 15 mm. thick if the waves were greater than $3 \cdot 2\,\mu$, but had different transmissibilities for waves less than this. The best glass for transparency and dispersion was D/262. A thickness of 15 mm. of it transmitted 90 % of the radiation less than $2 \cdot 14\,\mu$, and the fraction decreased up to $2 \cdot 75\,\mu$ where it was 74 %. It then decreased very rapidly to $3\,\mu$, where absorption was complete. This glass can be particularly commended for use in such cases as required. S. G. B.

1624. *On the Use of Spectroscopic Instruments of High Resolving Power.* **V. Ronchi.** (N. Cimento, 2. pp. 1–16, Jan.–Feb.–March, 1925.)—Theoretical resolving power demands optical perfection in all the optical systems traversed by the light between the entrance slit and the observing eye-piece on the photographic plate. In order to test the accuracy of an instrument the problem is to verify, within practical limits, the optical perfection of the luminous wave after it has passed through the telescopic eye-piece. A simple manner of achieving this is by the method of the interference fringes. If the wave be regular, the field should appear uniform and the fringes rectilinear, parallel, and equidistant according to whether the grating is in or removed from the focus. Inversely, these appearances being verified, the wave is regular and the resolving power theoretical. To determine the resolving power of a given instrument the author suggests using finer and finer gratings till one is found which gives a uniform field when placed in the focus. The paper gives details of various tests carried out and illustrations of fringes observed in the course of the experiments. E. F.

1625. *A Recording Microphotometer with a Photoelectric Cell.* **P. Lambert** and **D. Chalonge.** (Comptes Rendus, 180. pp. 924–926, March 23, 1925.)—Without taking special precautions, accurate photometric measurements cannot be made using a photoelectric cell whose current is amplified by means of a valve with three or four electrodes. An arrangement is described which ensures a sufficiently stable plate current proportional to the intensity of the light incident on the cell. This, with a photographic recorder, has been successfully used to map out the distribution of intensity in the ultra-violet spectrum of the sun. G. A. S.

1626. *Photometric Comparator.* **C. Pulfrich.** (Zeits. Instrumentenk. 45. pp. 35–44, Jan.; 61–70, Feb., and pp. 109–120, March, 1925.)—Describes a form of diaphragm photometer consisting of a double telescope with single eye-piece. The image of a diaphragm placed over each objective is formed at the eye-piece by way of a total reflection prism and a photometric comparison prism, so that the eye sees a double field in which the two parts are the apparent surfaces of the two objectives. Photometric balance is obtained by altering the aperture of one of the diaphragms. In front of the two diaphragms are placed the two diffusing surfaces whose brightnesses are to be compared. The instrument can be used as a reflectometer, a colorimeter, nephelometer, tyndallimeter, etc.
J. W. T. W.

1627. *Stereoscopic Micro-radiography in Relief and Pseudo-Relief.* **P. Goby.** (Comptes Rendus, 180. pp. 735–737, March 9, 1925.)—A special arrangement is described, based upon a new method, which remedies a defect in the apparatus previously described by the author [see Abstract 787 (1913)]. Details of the new attachment are given, together with a photograph showing the parts.
A. E. G.

1628. *Diffraction Phenomena presented by a Set of Alternatively Transparent and Opaque Sectors.* **A. Boutaric and (Miss) F. Demora.** (Comptes Rendus, 180. pp. 656–658, March 2, 1925.)—With a system of alternatively transparent and opaque sectors, issuing from a common centre, and illuminated by monochromatic light, a set of circular fringes is observed on a suitably disposed screen. With white light the corresponding set of coloured fringes is observed. The sector systems are obtained by the usual photographic methods, systems of 64 opaque and 64 transparent sectors, and of 128 opaque and 128 transparent sectors respectively being studied. The nature and dimensions of the observed fringes are treated analytically. The radii of consecutive bright rings are proportional to the square root of the entire successive numbers, and rings of the same order vary as the square root of the wave-length of the light used.
A. B. C. L.

1629. *Physico-Chemical Properties of Gelatin. Rotary Power.* **F. Vlès and E. Vellinger.** (Comptes Rendus, 180. pp. 439–442, Feb. 9, 1925.)—The diffusion of light by gelatin gels is at a maximum at the isoelectric point (p_H 4·7) and exhibits minima at p_H 2·6 and 13; the polarisation is almost negligible for axial diffusion. At the ordinary temperature, but not at 40°, freshly prepared gels exhibit mutarotation which is most marked at the isoelectric point. The rotatory power (which is negative) exhibits at the isoelectric point a singular value, this being a maximum at 12–15° and a minimum at 40°. **Erratum** (*ibid.*, p. 620, Feb. 23, 1925).
T. H. P.

1630. *Variation of the Rotary Power of Tartaric Acid as a Function of p_H.* **F. Vlès and E. Vellinger.** (Comptes Rendus, 180. pp. 742–745, March 9, 1925.)—The rotatory power of tartaric acid at 19° rises rapidly as the value of p_H increases from 2 to 5, and then remains sensibly constant until the value 13 is reached, after which it falls slightly. The corresponding curve resembles a neutralisation curve, and is explainable by regarding the rotation of the acid as the sum of the rotations of its two ions and its dissociation residue. T. H. P.

1631. *Wave-length Shifts in the Scattering of Light.* **P. D. Foote** and **A. E. Ruark.** (Science, 61. pp. 263–264, March 6, 1925.)—The wave-length shift may be vary large in certain favourably chosen cases of the scattering of ordinary light. A part of this frequency shift is the quantum analogue of the phenomenon predicted by Kramers and Heisenberg [see next Abstract]. In general, the wave-length change is due to three influences—the Doppler shift, caused by the initial movement of the atom; the Compton shift, due to the recoil of the atom or the ejected electron; and the shift due to alteration in the internal energy of the atom. To a first approximation these are additive. A. D.

1632. *Scattering of Radiation by Atoms.* **H. A. Kramers** and **W. Heisenberg.** (Zeits. f. Physik, 31. 9. pp. 681–708, 1925.)—When an atom is exposed to an exterior monochromatic radiation of frequency ν, it sends out not only secondary monochromatic spherical waves of the frequency ν coherent with the incident radiation, but also the principle of correspondence demands that it should in general send out spherical waves of other frequencies. These frequencies are all of the form $\nu + \nu_1$, where $h\nu_1$ is the energy-difference of the atom between the condition considered and some other condition. The non-coherent scattered radiation corresponds partly to certain processes discussed by Smekal from the point of view of quantum theory. The authors show how a wave-theory treatment of scattered radiation, along with the principle of correspondence, leads unconstrainedly to apparently unique results. The expressions arrived at lead to the same association of radiation from the atom with a stationary condition of the atom as that recently discussed by Bohr, Kramers and Slater. A. D.

1633. *Test Solutions for Heterochromatic Photometry.* **K. S. Gibson.** (Optical Soc. of America, J. and Rev. Sci. Inst. 9. pp. 113–121, Aug., 1924.)—In 1915 Ives [Abstract 843 (1915)] proposed the use of certain yellow and blue solutions as a means of testing individual observers in heterochromatic photometry. With standard carbon filament lamps, operating at 4 watts per candle, the integral light transmissions of the two solutions should be equal for the average observer, *i.e.* the ratio Y/B should be unity. In a test of 115 observers Crittenden and Richtmyer found values for Y/B from 0·977 to 0·987, instead of 1·000, and the solutions were accordingly slightly modified. The paper summarises further tests on these. The nature of the solutions as now adopted and their transmittances are explained and illustrated in tables and diagrams. From the data available it is concluded that uncertainties arising from the spectral transmission data are not greater than $\pm 1\,\%$, and that the ratio Y/B for these solutions is, as nearly as can be determined, exactly 1000. J. S. D.

1634. *The Oxalic Acid-Uranyl Sulphate Ultra-violet Radiometer.* **W. T. Anderson, Jr.,** and **F. W. Robinson.** (Am. Chem. Soc., J. 47. pp. 718–725, March, 1925.)—The photochemical decomposition of aqueous

oxalic acid solution sensitised by uranyl sulphate has been investigated by Mathews and Dewey [J. Phys. Chem. 17. 216, 1913]. The present authors have studied this reaction exhaustively, and find that it possesses the desired characteristics for an ultra-violet radiometer. It is a simple reaction, easily followed, proceeds with a moderate velocity, is readily reproduced, and is sensitive throughout the range of ultra-violet emitted by a quartz mercury arc, and to the ultra-violet alone. Two stock solutions are employed: (1) 6·3 gms. of pure oxalic acid crystals and 4·27 gms. of $UO_2SO_4 . 3H_2O$ are dissolved in 1 litre of distilled water; (2) a 0·1 N solution of potassium permanganate solution is prepared, to be standardised against the oxalic acid solution. 25 c.c. of solution (1) are exposed to the radiation in a transparent fused-quartz vessel, and after a definite time titrated against solution (2). The result may then be stated in milligrammes of oxalic acid decomposed or may be expressed in ergs. For example, with the above solutions, and under certain specified conditions, 1 mg. of oxalic acid, decomposed in 30 minutes, corresponds to $4·84 \times 10^5$ ergs per sec. for the complete ultra-violet. The method is of sufficient accuracy for ordinary determinations, does not require frequent calibrations, is not affected by vibration and magnetic disturbances, and requires no correction for visible and infra-red radiations. The temperature coefficient is only 1·035 for an interval of 10° C.
T. B.

1635. *The Photochemistry of Silver Compounds.* **J. Eggert** and **W. Noddack.** (Zeits f. Physik, 31. 12. pp. 942–948, 1925.)—In order to explain the difference in the results obtained on the photolysis of the Valenta emulsion the methods employed by Weigert, Schöller and Schubert are compared with those of the present authors. The quantity of silver, which is separated by wave-lengths 436, 405 and 365 $m\mu$ as well as by white light, is at first proportional to the amount of light; there is no S-formed rise of these curves. Chloride of silver is in an increasing degree photo-sensitive for wave-lengths 436, 405 and 365 $m\mu$. The quantum-equivalent law for silver chloride as absorbing substance is approximately fulfilled; it fails completely for the active absorption of photolised silver.
A. E. G.

1636. *Proof of Quantum-Equivalent Law in some Silver Halide Emulsions.* **J. Eggert** and **W. Noddack.** (Zeits. f. Physik, 31. 12. pp. 922–941, 1925.)—The true absorption of a pure chloride of silver emulsion plate is determined for different ranges of the spectrum by a previously described method [see Abstract 490 (1924)]. By a comparison of the absorbed number $h\nu$ with the number of silver atoms formed, it is shown that for wave-length 365 $m\mu$ a molecule of pure chloride of silver is broken up per quantum. For $\lambda = 436$ $m\mu$ and $\lambda = 405$ $m\mu$, assuming the validity of the quantum-equivalent law, the active absorption is calculated to 0·003 and 0·01 respectively. In a similar manner the behaviour of the Valenta emulsion with lighting is studied. The green sensitivity of Valenta emulsion, previously exposed with $\lambda = 436$ $m\mu$, then exposed for varying times with $\lambda = 546$ $m\mu$, is quantitatively investigated. These effects, contrary to the usual explanation, are not considered as due to the sensitising action of silver, but are looked upon as photolysis by previous exposure of an adsorption combination originating between silver and silver halide. The silver halide emulsions previously investigated are compared with one another and the reason for their difference is discussed. A. E. G.

1637. *Relationship of Photographic Emulsion Fog to Grain Size.* **A. P. H. Trivelli, E. P. Wightman and S. E. Sheppard.** (Eastman Kodak Co. Research Lab. Comm. No. 214. Phot. J. 65. pp. 134–137; Disc., 137–140, March, 1925.)—A study is being made of what is here called "emulsion fog" or "emulsion-time fog." It consists of a latent developability of some of the grains of the photographic emulsion produced in the plates on standing, without exposure to light, for a greater or less period of time. The term is used in counter-distinction to ordinary "development fog" or "development-time fog" produced by prolonged development, and might also be called "deterioration fog," since it renders the plate more or less useless for ordinary photographic work. Whether or not there is any real difference between the two kinds of fog is not known. It may be that they are both the same fundamentally, but appear at a faster or slower rate in different emulsions according to their methods of preparation. A speculation is made as to the meaning of "k," the "fog coefficient." The paper is somewhat adversely criticised in the *Discussion* by **Bloch, Slater Price, Toy** and **Clark,** to which a reply is made by the authors. A. E. G.

1638. *The Diminution of Fluorescence in Colour Solutions at Great Concentrations.* **S. J. Wawilow.** (Zeits. f. Physik, 31. 10. pp. 750–764, 1925.)—The fluorescence of certain liquid solutions, fluorescine and eosin, are investigated quantitatively with respect to the amount of concentration. For weak solutions the fluorescence is almost independent of the concentration, but at a definite strength of solution the fluorescence begins to diminish, following an exponential law until the solution becomes very concentrated. The curves giving this relation of fluorescence to concentration show no relation to those for the conductivity of the same solutions. Thus it is concluded that an explanation cannot be found in the electrolytic theories. A theory is put forward connecting the phenomena with the Brownian movements. J. R.

1639. *Absorption of Fluorescent Light in the Emitting Substance.* **T. Duseberg.** (Phys. Zeits. 26. pp. 157–166, Feb. 1, 1925.)—An examination has been made of the properties of the fluorescent light and the spectral changes occurring in the absorption of this light in solutions of isoquinoline red, uranine, aniline yellow, and quinine sulphate. An extension of Stokes' law is proposed. A. B. W.

1640. *Radiation emitted by badly conducting Substances when traversed by an Electric Current.* **G. Reboul.** (Comptes Rendus, 180. pp. 916–919, March 23, 1925.)—Measurements of the coefficients of absorption of the radiation emitted from mercuric oxide, when carrying a current, have been made with varying pressures from atmospheric to 6 cm. of mercury. The coefficient of absorption by air under these conditions varies from 20 to 174. Experiments made in hydrogen and CO_2 lead to analogous results. [See Abstract 2755 (1924).] A. B. W.

1641. *Calorimetric Measurements relating to the Pressure of Light and Photophoresis.* **J. Ramler.** (Zeits. f. Physik, 31. 7–8. pp. 592–603, 1925.)—A calorimeter, comprising a copper vessel enclosed within a silvered glass vessel and thermally insulated from its surroundings by a vacuum, suitable for the measurement of the energy in a beam of radiation and for the investigation of photophoresis is described [see Abstract 1085 (1918)]. The two forms of calorimeter employed by Lebedew [see Abstract 834 (1902)] are considered to be unsatisfactory for these purposes owing to uncertainty as to the temperature of the surroundings. The application of the calorimeter to the determination of the radiation from carbon arcs, as in Ehrenhaft's work, is described. J. S. G. T.

1642. *Rectification of Light of Neon Tubes.* **G. Claude.** (Comptes Rendus, 180. pp. 890–892, March 23, 1925.)—In the mercury-neon tubes used to obtain blue light, and specially those of small diameter (8 to 10 mm. outside measurement) it is found that variations of temperature influence greatly the quality of the light. When the temperature is high only the spectrum of Hg is visible; as the temperature is gradually lowered neon lines appear. A tube with alternating large and small diameters is used, and it is found that by this means the neon light is corrected by the mercury light by means of a single tube, a result which has not been found possible hitherto. Contrary to what was first expected, it is found that in the hotter parts of the tube the light is due to neon and not to mercury. An explanation of this phenomenon is given. A. E. G.

1643. *Spectroscopy in the Infra-red Region.* **A. Trowbridge.** (Frank. Inst., J. 199. pp. 343–352, March, 1925.)—This address contains an historical account of work in the infra-red region, including that on series and band-spectra. F. S.

1644. *Photography in Spectrum Analysis.* **T. T. Baker.** (Imp. Dry Plate Co., Ltd., Research Lab. Comm. No. 9. Phot. J. 65. pp. 145–154; Disc., 154–155, March, 1925.)—The object of this paper is to place on record the present-day position, and the subject is therefore dealt with in a general manner throughout. Several photographs of spectra are given. A. E. G.

1645. *Spreading of Spectral Lines.* **J. Holtsmark** and **B. Trumpy.** (Zeits. f. Physik, 31. 10. pp. 803–812, 1925.)—Measurements of the breadths of selected lines in the arc spectrum of Li, Ag, Cu, Ni; comparison with breadths calculated from the Stark-effect; good agreement found, even in cases where the admissibility of the calculation seemed doubtful on account of the non-homogeneity of the molecular electric field. A case of apparent spontaneous inversion, Ag λ4055, readily explained as a special case of the Stark-effect. Calculation of the strength of the molecule-electric field in the electric arc. A. D.

1646. *Structure of a Class of Band-spectra.* **R. Mecke.** (Zeits. f. Physik, 31. 9. pp. 709–712, 1925.)—A consideration of certain band-spectra shows an anomaly in the intensities of lines in some series when the particle emitting the spectrum consists of a molecule with two equal atoms. These anomalies can be resolved by supposing two emitting electrons which share the total impulse equally between them. F. S.

1647. *Infra-red Absorption Spectra of Alcohols.* **J. Lecomte** (Comptes Rendus, 180. pp. 825–827, March 16, 1925.)—For measurements in the region 2·75 μ to 8 μ, a fluorite prism has been used for which the dispersion warrants an accuracy of 0·01 μ. All the alcohols studied show strong absorption at 3 μ to 3·5 μ and 6·85 μ to 8 μ. There is feeble absorption between 3·5 μ and 6·85 μ except in a few cases in which there is strong absorption between 5·80 μ and 6·15 μ. The results are summarised in a table. F. S.

1648. *Spark Spectrum of Mercury in the Extreme Red.* **J. Laffay.** (Comptes Rendus, 180. pp. 823–825, March 16, 1925.)—The source was a mercury tube without electrodes activated by a high-frequency discharge. The spectra were photographed with a concave grating of 3 m. radius mounted stigmatically, the second order being used as far as 6500 Å. and the first order beyond that limit. The plates were bathed with pinacyanol and dicyanine. A table is given of wave-lengths from $\lambda = 5935$ to $\lambda = 7985$, the arc lines and orders of spark line being indicated. F. S.

1649. *The Isotope Effect in Band-Spectra. Part II. The Spectrum of Boron Monoxide.* **R. S. Mulliken.** (Phys. Rev. 25. pp. 259–294, March, 1925.)—The methods of Part I [see Abstract 1367 (1925)] are applied to the band-spectrum ascribed by the author to BO, and by Jevons, who first measured it, to BN. New spectrograms were taken, and over 100β and about 200α heads were measured, and are tabulated with their intensities. Each of these systems is composed of two closely similar, superposed systems, the weaker and larger scale one being shown to be due to the less abundant isotope $B^{10}O$, and the other to $B^{11}O$, with no indication of other isotopes. The measurements are not consistent with the theory that the spectra are due to BN, and a good deal of additional outside evidence is adduced to show that they belong to BO. It is probable that the minimum values of n' and n'', the initial and final vibrational quantum numbers, are not zero, but $\frac{1}{2}$. Energy level diagrams are given for both isotopes, with the actual transitions and intensities; the final state for both α and β systems is probably the normal state of the molecule. Measurements of the structural lines of three β bands approximately confirmed the theory of the rotational isotopic effect, and gave approximate equations for the origins of the α and β bands and values for the internuclear distance for BO. A new system of BO bands of low intensity was investigated, the arc and active nitrogen spectra of BO were compared, and the differences between them are explained. A possible analogy of BO and CN to the Na atom is discussed; all three have nine outer electrons, of which the first eight possibly form an octet, with the ninth in a loosely bound orbit. The α and β systems of BO and the red and violet CN bands then correspond to the first two members of the principal series of Na. H. N. A.

1650. *The Series Spectra of Lead and Tin.* **H. Sponer.** (Zeits. f. Physik, 32. 1. pp. 19–26, 1925.)—With the aid of the inner quantum numbers it is shown that the fundamental terms in the arc spectra of tin and lead are p terms, with the inner quantum numbers 0, 1, 2, 2 for lead, and 0, 1, 2, 2, 0 for tin. Further, the terms p_0, p_1, and p_2 form the fundamental term of the Thorsen series. Further regularities are given, the paper containing a number of references to the principal work on the subject. W. V. M.

1651. *Regularities in the Arc Spectrum of Nickel.* **F. M. Walters, Jr.** (Washington Acad. Sci., J. 15. pp. 88–100, March 4, 1925.)—This paper gives preliminary results for nickel similar to those already given for iron and cobalt [see Abstract 568 (1925)]. The alternation law is obeyed in the eighth column of the periodic table, for while in the iron spectrum terms are of odd multiplicity (3, 5 and 7 fold), in cobalt they are even (2 and 4), and odd values (1 and 3) appear again in nickel. In addition to wave numbers *in vacuo*, the intensities and character as given by Hamm are listed. The lines are classified with regard to Zeeman-effect, and King's temperature classes are also indicated. F. S.

1652. *Spark Spectrum of Neon.* **L. Bloch, E. Bloch** and **G. Déjardin.** (Comptes Rendus, 180. pp. 731–733, March 9, 1925.)—The method used recently to isolate spark-spectra of successive orders in argon, krypton and xenon has been used to distinguish the first order spark-spectrum in neon. A list of wave-lengths between 4922 Å. and 2757 Å. is given, for which an accuracy of from 0·05 Å. to 0·10 Å. is claimed. **Erratum** (*ibid.*, p. 1080, March 30, 1925). F. S.

1653. *Apparent Tripling of Certain Lines in Arc Spectra.* **T. Royds.** (Roy. Soc., Proc. 107. pp. 360–367, Feb. 2, 1925.)—The author has searched as many spectra as possible through the visible region for instances of lines becoming complex when the amount of material in the arc was increased. Only seven cases were found, all being of similar type in becoming apparently triple with a sufficient quantity of material. The Tl line was found to pass through five successive phases—*viz.*, broad simple reversal, triplet, doublet, a second triplet form, and a final doublet—as the amount of material in the arc burns out. It is shown that the Tl 5350 line is essentially a doublet, and that all the different phases can be simply explained as different stages in the self-reversal of the two lines of the doublet. The same explanation of self-reversal of an essential doublet was adopted for the six remaining instances of apparent tripling, as all except two were found to assume a doublet form in the final phase; in the two exceptions the doublet was expected to be difficult to resolve. A. B. W.

1654. *Addendum to the Paper "On an Absorption Line of the Iodine Atom."* **C. Füchtbauer, F. Waibel** and **E. Holm.** (Zeits. f. Physik, 31. 7–8. p. 523, 1925.)—It has been found that the absorption line discovered by the authors [Abstract 358 (1925)] agrees with an emission line found by Oldenberg [Abstract 2498 (1924)], and whose wave-length is 2062·25 Å. when reduced to *vacuo*. Other iodine lines have been found on the short wave-length side of this line, in particular 1877 Å., which may be the second member of an absorption series. W. V. M.

1655. *L-absorption Spectra of Elements from Sn* (50) *to W* (74). **Y. Nishina.** (Phil. Mag. 49. pp. 521–537, March, 1925.)—Previous work on L-absorption spectra of nine elements between La (57) and Hf (72) is now extended to give more accurate values of the energy levels from Sn to W.

Siegbahn's vacuum spectrograph and metal X-ray tube were used, the latter being excited by a 30,000-volt transformer and kenotron rectifier. The absorption screen is placed between slit and crystal, and formed by rubbing the finely powdered compound of the element in question upon silk paper. Exposures for absorption, using continuous radiation from a tungsten antikathode, varied from two to fifteen hours, while emission lines for reference were recorded in a quarter to half an hour. Spectrograms are reproduced showing absorption as white lines, and corresponding photometric curves are also given. In addition to experimental results, energy levels for all elements in this range are tabulated. The accuracy of measurement is about 0·7 X.U. F. S.

1656. *Intensities in the many-lined Spectrum of Hydrogen.* **G. H. Dieke.** (Zeits. f. Physik, 32. 3. pp. 180–185, 1925.)—A discussion of the intensity measurements of F. Goos [Abstract 1379 (1925)] in conjunction with Fulcher's law of bands. The quantum theoretical explanation of this law, first given by Lenz, is insufficient to account for the finer structure of the bands, and another interpretation was proposed by the author [see Abstract 560 (1925)]. Tables are given showing the intensities according to Merton, Barrat and Watson, and the observations of McLennan and Shrum. E. F.

1657. *The Fulcher Hydrogen Bands.* **W. E. Curtis.** (Roy. Soc., Proc. 107. pp. 570–587, March 2, 1925.)—The Fulcher lines and Allen's additions to them have been examined with a view to finding a theoretical interpretation of them. The wave-numbers of two of the strongest lines are shown to require correction by about 0·5 cm.$^{-1}$. The differences are then sufficiently regular to provide a criterion for the genuineness of the extra lines, which are in the main confirmed. Discarding all doubtful lines, the Fulcher triplets then become quintuplets, and the second set quadruplets. The arrangement is shown to be consistent with the view that they originate from combinations of simultaneously occurring rotation and vibration changes. The relevant quantum numbers cannot be determined with certainty, but their most probable values are indicated. New and more accurate values of the molecular moments of inertia concerned are obtained. These, however, refer to an excited molecule. It appears that the nuclear vibrations within the hydrogen molecule are very nearly simple harmonic, which would account, in conjunction with the small moment of inertia, for the unique structure of the system as compared to other band systems. Although it does not seem possible that the two sets of Fulcher triplets can originate from the same molecule, it is concluded that the two molecules concerned must be essentially similar in structure. W. V. M.

1658. *On the Intensities of the Multiplet Lines.* **A. Sommerfeld** and **H. Hönl.** (Preuss. Akad. Wiss. Berlin, Ber. 9. pp. 141–161, 1925.)—The Utrecht measurements have shown that the summation rules of Burger and Dargelo are valid for the relative intensities of the spectral lines of a multiplet. These rules, however, are applicable only in the case of doublets for the determination of separate intensities, and an integer hypothesis has to be invoked for the higher multiples. The original form of this latter hypothesis has proved inadequate, but in the present paper reasons are advanced to support the view that the relative intensities within every multiplet are rational, and can be expressed by whole numbers. The discussion is not intended to replace the summation rules, but to derive a general framework whereby the intensity relations are expressible by quantum numbers and a standpoint afforded for obtaining analytical expressions. The paper is entirely mathematical and subdivided as follows: § 1. The multiplets $k \rightarrow k - 1$; § 2. Comparison with fact; § 3. The multiplets $k \rightarrow k$; § 4. Comparison with experience; § 5. Additional matter for the construction of the intensity formulæ; § 6. Numerical-graphical evaluation. The solution of the intensity problem of multiplets is thus sought after from the practical side. H. H. Ho.

1659. *Soft X-Rays from Iron.* **C. H. Thomas.** (Phys. Rev. 25. pp. 322–332, March, 1925.)—Critical potentials of iron to 900 volts were determined photoelectrically. Soft X-radiation from a polished iron target bombarded by electrons from a filament heated by a current constant to 0·01 % produced a photoelectric current from a platinum semicylinder, which was so placed that all the radiation from the target fell on it and was protected from strong electricity by a system of radially disposed nickel vanes charged alternately positively and negatively. A vacuum of 10^{-6} mm. or better was maintained. When the ratio of the photoelectric current to the thermionic bombarding current was plotted as a function of the exciting voltage a number of breaks appeared. From the similarity of the curves thus obtained to those observed with gases, breaks at radiation potentials were distinguished from those at ionisation potentials. The fact that radiation excited by 2·3 volt-electrons produced a photoelectric current can be explained by taking Einstein's complete equation $h\gamma = e(\nu + \phi)$, where ϕ is the work function of iron whose value is calculated to be 5 volts. Correcting for this, about twenty-three radiation potentials were located and nine ionisation potentials. The ionisation potentials at 818·5, 704·3 and 54·6 volts are identified with the the lines L_I, L_{III}, and M_{III}. W. V. M.

1660. *The Variation with Temperature of the Intensity of Reflection of X-Rays from Quartz and its Bearing on the Crystal Structure.* **R. E. Gibbs.** (Roy. Soc., Proc. 107. pp. 561–570, March 2, 1925.)—Investigations by the X-ray spectrometer enabled Bragg to give the dimensions of the unit triangular prismatic cell as $a = 4\cdot89$ Å.U. and $c = 5\cdot375$ Å.U., three molecules being associated with it. There are, however, still four unknown parameters, *viz.*, the radius of the silicon spiral and the position of the oxygen atoms relative to the silicon. The oxygen planes are equidistant above and below the silicon planes at a distance d, which determines the relative intensities of the various orders. It is shown that $d = 0\cdot63$ or $c/9$ approximately, and not equal to zero as suggested by Huggins and McKeehan. As a small change in d alters the intensities considerably, it was expected that the changes occurring at 575° C. would show in the intensity-temperature curves, and this is found to be the case. Measurements were made by the ionisation method on the first and second order reflections from planes 111, $\bar{1}10$, $2\bar{1}\bar{1}$ for K_α of molybdenum, and the curves show rapid variation in intensity near the transition point. The value of d has been calculated at different temperatures from the variation of intensity of the 111 plane. The X-ray results are compared with a number of physical properties of quartz, and the type of change occurring at the transition is discussed. W. V. M.

1661. *Influence of Temperature on Intensity of Reflection of X-Rays from Rock-salt.* **R. W. James.** (Phil. Mag. 49. pp. 585–602, March, 1925).—The paper deals with a series of measurements of the intensity of reflection of X-rays from the (100) face of a rock-salt crystal at temperatures between 19° C. and 650° C. The spectra investigated were the second, third and fourth orders, using molybdenum K_a radiation, and the third order, using rhodium K_a radiation. A theoretical formula obtained by Debye shows that if R_T is the intensity of a spectrum reflected at a glancing angle θ at absolute temperature T, R_0 that at absolute zero,

$$R_T = R_0 e^{-bf(T) \sin^2 \theta/\lambda^2} = e^{-M}$$

where b is a constant and $f(T)$ is some function of the temperature. The theory indicates further that over the range of temperature employed M is of the form $- aT \sin^2 \theta/\lambda^2$. The experiments show that M is proportional to $\sin^2 \theta/\lambda^2$ for all the spectra investigated, but that instead of being proportional to T it is proportional to T^2. The results obtained may be expressed by the empirical formula

$$R_T = R_0 e^{-1 \cdot 162 \times 10^{-5} \sin^2 \theta/\lambda^2 . T^2}$$

where λ is expressed in Ångström units. The intensity diminishes as the temperature rises much more rapidly than theory indicates. A. B. W.

1662. *Note on the Quantum Theory of the Reflection of X-Rays.* **W. Duane.** (Nat. Acad. Sci., Proc. 11. pp. 175–178, March, 1925.)—Using the theory put forward in a previous paper [Abstract 2430 (1923)] the author deals with the case of an incident X-ray, which splits off an electron and causes an atom in the crystal to radiate its fluorescent spectrum; here an additional assumption is made that the total fluorescent radiation from an atom quantises its momentum with the crystal. If λ_1 is the fluorescent ray of greatest energy emitted by the atom, then θ_1, the angle at which it can be reflected, can have only certain values, and a figure shows graphically for a given case, for reflections from the 100 planes of the crystal, the probability of these different values. The points representing corresponding values of θ and θ_1 (θ being the angles of incidence) are in part concentrated about a point, A, corresponding to the ordinary law of reflection, $\theta = - \theta_1$, partly about another point, B, where, for the case considered, $\theta = + 20°$ and $\theta_1 = + 2 \cdot 5°$, roughly, and partly scattered sparsely along a curve passing through the above two points. Thus, from the theory, for every regular reflection corresponding to A there should be an abnormal one of about equal intensity corresponding to B; but the facts do not agree with this, and it seldom occurs that an abnormal reflection is as strong as the normal ones. This addition to the theory is thus not justified by experiment; the law of the transfer of momentum in quanta applies to the individual fluorescent quanta, and not to the sum total of all the fluorescent rays only. H. N. A.

1663. *Focussing Method of Crystal Powder Analysis by X-Rays.* **J. Brentano.** (Phys. Soc., Proc. 37. pp. 184–193, April, 1925.)—The conditions of reflection of X-rays from a thin layer of crystal powder are investigated, and it is pointed out that for any given angle of reflection a surface of double curvature can be found, such that it will reflect X-rays coming from one point to any other definite point. For an element of this surface, situated so as to be distant from the two points by lengths a and b respectively, the relation $\frac{\sin \alpha}{\sin \beta} = \frac{a}{b}$ must be satisfied where α and β are the glancing angles of incidence and of emergence of the X-rays with respect to the surface. An arrangement for crystal analysis based on this relation is discussed and expressions are given for its resolving power. An apparatus of this type for photographic work and a hot kathode X-ray bulb of simple design are described. A new determination of the lattice constant of nickel oxide is also given. [See also Abstract 546 (1924).] AUTHOR.

1664. *Spectral Frequencies in the Region between Visible Light and X-Rays.* **F. Holweck.** (Comptes Rendus, 180. pp. 658–661, March 2, 1925.)—A method is described for the accurate measurement of wave-lengths lying within the region $\lambda = 140$ Å.U. and $\lambda = 12$ Å. Measurements by previous investigators appear to be very discordant. The author's method employs the principle of absorption of the rays in the gas to be studied, the pressure being regulated until the critical potential is reached, described in detail in a previous note [see Abstract 1109 (1925)]. The critical potentials of the following elements (Cl, S, P and Si) were determined, the elements being in the combined forms HCl, H_2S, H_3P, H_4Si respectively. To complete the series a re-determination of the critical potential of Al was made by a method previously described. A. B. W.

1665. *An Investigation of the Absorption of Superposed X-radiations.* **W. H. Watson.** (Roy. Soc. Edinburgh, Proc. 45. 1. pp. 48–58, 1924–1925.)—When the mass absorption coefficients of X-rays by aluminium and copper are compared it is found that, as the tube is hardened, there is a sudden increase in that of Al. The phenomenon cannot be explained simply in terms of a J series characteristic radiation. It seemed possible that the change in the aluminium was such that it behaved as the element of next higher atomic number, and that if this were the case there would be an increase in the absorption of another beam of X-rays, of different quality, passing through the transformed aluminium at the same time. In the experiments both beams involved were derived from the same X-ray bulb, one of them being modified by filters. Owing, however, to the difficulty of controlling the critical conditions the experiments led to no definite result. Further observations were made on aluminium to find out if a phenomenon existed similar to that observed by C. T. R. Wilson in cloud photographs of the β-ray tracks due to X-rays in air, when some of the tracks were paired. The author thought that Wilson's explanation of this phenomenon made it probable that, if a sufficiently hard primary X-ray beam could be directed on a solid element, the absorption of a second X-ray beam characteristic of the element would be increased. Here again, however, the result of the experiments made cannot be regarded as conclusive, and there is no evidence at present of effects of the magnitudes to be expected on the grounds which suggested the investigations. H. N. A.

1666. *Absorption of X-Rays.* **E. C. Stoner** and **L. H. Martin.** (Roy. Soc., Proc. 107. pp. 312–331, Feb. 2, 1925.)—A description is given of a balance method for the measurement of X-ray absorption. The series of slits of a Bragg spectrometer is replaced by a series of double slits (one vertically above the other), and the two beams of X-rays are reflected from a single large crystal into two separate ionisation chambers, which replace the usual single chamber. The currents through the two chambers are balanced by adjusting the heights of the slits, the absorbing screen is placed in the path of one of the beams, and the absorption compensated by moving a wedge of aluminium across the path of the other beam by means of a micrometer screw. The absorption for a particular wave-length can be accurately measured in terms of the absorption of the material of the wedge. Using a rotating sectored disc, the absolute absorption coefficient of Al has been determined for three wave-lengths ($\lambda = 0 \cdot 45$, $\lambda = 0 \cdot 631$ and $\lambda = 0 \cdot 708$ Å.U.). Primarily comparative to Al, the absorption in Cu, Pd, Ag and Sn, and the relative absorption of uranium oxide have been investigated over a range of wave-lengths from 0·3 to 0·71 Å.U. The results are compared with those of previous observers. With reference to theories of X-ray absorption, the range of validity of the λ^3 and Z^4 laws and the magnitude of the K and L absorption discontinuities are briefly discussed. A. B. W.

1667. *The Level Values of the X-Ray Spectra of the Chemical Elements.* **D. Coster.** (Zeits. f. Physik, 31. 12. pp. 898–900, 1925.)—Criticises a paper by B. Walter [Abstract 1114 (1925)], which claims that the curves for the level values are smooth at certain points where Bohr and Coster have found sudden bends. The difference of frequency between the K absorption limit and the $K\beta_2$ line is equal to the value of the energy level $N_{II, III}$ (N_{II} and N_{III} cannot be separated experimentally in the region under consideration). In analogy with the behaviour of the level curves for the same earths the curve of the $N_{II, III}$ level should have sharp bends in the neighbourhood of the palladium group. Walter, however, has assumed that this is not the case, and this accounts for the smooth course he has deduced for the K-absorption limit. The author also shows that in any case the $K\beta_2$ line used by Walter is not very suitable for the purpose. In the case of tungsten the L-absorption limit is much more suitable for the purpose than the K one, and the same is true for other heavy elements. H. N. A.

1668. *The Relative Intensities of Fluorescent and Scattered X-Rays.* **G. L. Clark** and **W. Duane.** (Nat. Acad. Sci., Proc. 11. pp. 173–175, March, 1925.)—Refers to previous experiments [see Abstract 1819 (1924)] and to a paper by Allison and Duane [Abstract 1405 (1925)]. The experiments here described were carried out to verify the previous results. It was found that the scattered radiation from the light chemical elements has a very much greater intensity than from the heavy; this agrees with previous results. The scattered and tertiary radiation, due to tungsten X-rays falling upon elements of atomic weights near that of molybdenum, are extremely weak as compared with the fluorescent radiation, and cannot be studied accurately with the existing apparatus. The large currents in former experiments representing scattered and tertiary radiation were due to some other unexplained cause. H. N. A.

1669. *Measurements of β-Rays associated with scattered X-rays.* **A. H. Compton** and **A. W. Simon.** (Phys. Rev. 25. pp. 306–313, March, 1925.)—Stereoscopic photographs of β-ray tracks excited by strongly filtered X-rays in moist air have been taken by the Wilson cloud expansion method.

In accord with earlier observations by Wilson and Bothe, two distinct types of tracks are visible, a longer and shorter type, called P and R tracks respectively. Using X-rays varying in effective wave-length from about 0·7 to 0·13 Å., the ratio of the observed number of R to that of P tracks varies with decreasing wave-length from 0·10 to 72, while the ratio of the X-ray energy dissipated by scattering to that absorbed (photoelectrically) varies from 0·27 to 32. This correspondence indicates that about one R track is produced for every quantum of scattered radiation, assuming one P track is produced by each quantum of absorbed X-radiation. The ranges of the observed R tracks increase roughly as the fourth power of the frequency, the maximum length for 0·13 Å. being 2·4 cm. at atmospheric pressure. About half the tracks, however, had less than 0·2 of the maximum range. As to angular distribution, of forty R tracks produced by very hard X-rays (111 kv.), thirteen were ejected at between 0° and 30° with the incident beam, sixteen at between 30° and 60°, eleven at between 60° and 90°, and none at a greater angle than 90°. The R electrons ejected at small angles were on the average of much greater range than those ejected at larger angles. These results agree in every detail with the theoretical predictions made by Compton and Hubbard, and the fact that in comparing observed and calculated values no arbitrary constant is assured makes this evidence particularly strong that the assumptions of the theory are correct, and that whenever a quantum of X-radiation is scattered, an R electron is ejected which possesses a momentum which is the vector difference between that of the incident and that of the scattered quantum. W. V. M.

1670. *Quantum Theory of the Unmodified Spectrum Line in the Compton-Effect.* **G. E. M. Jauncey.** (Phys. Rev. 25. pp. 314–322, March, 1925.)—The theory is based on the following assumptions: (*a*) The energy of the primary quantum plus the kinetic energy of the electron in the Bohr orbit (supposed circular) is equal to the energy of the scattered quantum plus the kinetic energy of the recoil electron after removal from the Bohr orbit and before it has escaped from the electrostatic field of the atom. (*b*) The vector sum of the momenta of the primary quantum and the electron in its orbit is equal to the sum of the momenta of the scattered quantum and the recoil electron just after removal from its orbit. (*c*) In order that the scattering take place according to (*a*) and (*b*), the difference between the energies of the primary and scattered quanta must at least equal the binding energy of the electron in the Bohr orbit. From these assumptions it is found that there are certain positions of the electron in its orbit from which the electron cannot be ejected by the quantum. In these positions the mass of the whole atom is added to that of the electron, and the change of wave-length is negligible. For Mo$K\alpha$ rays scattered by the K electrons of C, the theory indicates that there are no unmodified rays scattered at angles less than 23°, and that the change of wave-length of the modified rays scattered at 90° lies between 0·01 and 0·06 Å. These conclusions are in general agreement with the experimental results of Compton, Clark, Duane and Stifler. W. V. M.

1671. *The Motion of a Free Electron in the Field of a Plane Electromagnetic Wave.* **J. Frenkel.** (Zeits. f. Physik, 32. 1. pp. 27–31, 1925.)—In a recent publication [Abstract 1115 (1925)] Halpern has endeavoured to investigate the classical analogue of the Compton-effect, using the correspondence principle, and employed a method of approximation to solve the relativistic equations of motion. The present author investigates the problem rigorously. It is concluded that a photoelectric effect in the usual sense is impossible for free electrons, and that for bound electrons it must be a "resonance" effect, if we use the ideas of the correspondence principle. W. V. M.

RADIO-ACTIVITY.

1672. *The Preparation of Radium C. Part II.* **J. Ortner** and **H. Pettersson.** (Akad. Wiss. Wien, Ber. 133. 2a. No. 5–6. pp. 229–234, 1925.)—A continuation of a previous paper by Pettersson [Abstract 1198 (1924)], in which the method of preparing radium C by condensing radon on a metal surface by means of liquid air is described. The gas containing the emanation is reduced to a small volume; it consists largely of a mixture of oxygen and hydrogen, *Knallgas*. About 40 c.c. are produced per day per gramme of radium and can be removed by sparking in a suitable explosion burette. The small quantity of gas left consists of hydrogen, carbon dioxide from the tap grease of the apparatus, and traces of air. To get good results moisture and CO_2 must be removed, since otherwise the surface on which the deposit is to be made is covered with hoar-frost on cooling with liquid air, and when the radon is afterwards deposited some of the recoil atoms are prevented from hammering themselves into the metal. The special method adopted for this removal by means of potassium hydrate and phosphorus pentoxide is described, together with the further manipulations required in introducing the emanation into the activating vessel. Different forms of activating vessel are dealt with, arranged to produce RaC preparations of various forms by covering one side of a disc or a ring, the inner cylindrical surface of a hole turned in a thin sheet of copper, or a point at the end of a thin platinum wire with condensed emanation. H. N. A.

1673. *The Decay Constant of Radium Emanation.* **L. Bastings.** (Cambridge Phil. Soc., Proc. 22. pp. 562–566, March, 1925.)—A method has been devised and applied for measuring the decay constant of radium emanation, the method depending on careful comparisons with a simple electroscope under the most favourable conditions. A mean value for the constant of radium emanation has been obtained, with an error unlikely to exceed 0·2 %: $\lambda = 0{\cdot}1808$ day^{-1}, or half-period 3·833 days. [See also Abstract 587 (1925).] AUTHOR.

1674. *Decomposition of the Total Radiation from Radium into Groups by Means of Absorption in Platinum.* **J. S. Lattès.** (Comptes Rendus, 180. pp. 1023–1026, March 30, 1925.)—Radium bromide prepared in 1907 was employed, and contained the disintegration products which had accumulated during the interval; the complex radiation was similar to that used in therapeutics. The secondary radiations produced in the absorbing screens employed complicate the phenomena of absorption, so that the total radiation measured in the ionisation chamber consists of three groups of primary γ-rays, four of primary β-rays, three of secondary β-rays produced by the primary γ-rays, and some secondary γ-rays produced by the primary β-rays. A table gives the proportion of the different groups after passing through different thicknesses of platinum. H. N. A.

1675. *The Increase in the Heat produced by Radium Salts due to the Formation of Polonium.* **(Mme.) P. Curie** and **D. K. Yovanovitch.** (J. de Physique et le Radium, 6. pp. 33–35, Feb., 1925.)—The heat evolved by a radium salt, prepared in August 1907, was compared with that of a recent preparation, the amounts of radium being compared by means of measurements of the γ-rays given out from RaC contained in them. The heat per gramme of radium had increased in 16·75 years by 11 %, and this was due to the formation of polonium. The authors conclude that this formation has proceeded in a normal manner in the medium formed of chloride of radium. H. N. A.

1676. *A Thermal Spring of Great Radio-activity in St. Joachimstal, Bohemia.* **F. Běhounek.** (J. de Physique et le Radium, 6. pp. 48–51, Feb., 1925.)—The "Concorde" spring is situated in a uranium mine at Jachymov, at a depth of about 500 m.; its activity reaches $163 \cdot 8 \times 10^{-9}$ curies per litre of water, and the activity of the free gas is as high as $448 \cdot 0 \times 10^{-9}$ curies per litre of gas. Both activities are due to radon, and there is very little radium in the water, $2 \cdot 4 \times 10^{-13}$ gramme per c.c.; there is no thoron. It is thought that the water becomes activated in passing through the granite base on which the micaschists containing the pitchblende veins rest, and the activation is due to the radio-activity of the granite and not to contact with a rich pitchblende vein. Geological reasons are given for this opinion. H. N. A.

1677. *The Stability of Atoms.* **E. Rutherford.** (Roy. Soc. Arts, J. 73. pp. 389–402; Disc., 402–403, March 13, 1925.)—Gives a brief description of the Bohr theory as applied to hydrogen, and shows how the complicated spectrum observed in this simple atom is explained in terms of energy levels; considers the spectra of neutral atoms of other elements (arc spectrum) and singly, doubly, trebly and even, in the case of oxygen and sulphur, quintuply ionised atoms. X-ray spectra are described and explained in terms of the energy levels; the life of an atom in the excited states is considered; and the transfer of the potential energy of an excited atom so as to excite an atom of another element without the emission of radiation, as in the experiments of Franck and Cario on a mixture of Hg and Th, is mentioned. A nucleus which has lost an electron or an α-particle (radio-activity) does not regain it as does an atom which has lost an extranuclear electron. Attention is called to the results of Ellis on the γ-rays of RaB and RaC, which indicate transitions between definite stationary states in the nuclei, with simple systems of energy levels, so that quantum dynamics apparently applies to the nucleus as well as to the outer atom. There is no certain evidence that the nuclear electrons absorb the most penetrating γ-rays; it may be that the majority of them are so tightly bound that they no longer act like the more loosely bound electrons of the outer atom. A radio-active atom may be analogous to an "excited" atom, with an electron displaced to a higher energy level; the life of an "excited" nucleus is, however, in many cases enormous (millions of years in the case of uranium), as compared with that of an excited H-atom. In general it appears that energy must be expended to remove the protons and electrons of a nucleus to a great distance from each other; but a few α-satellites may become unstable by the expenditure of a certain amount of energy, and one of them may be removed from the attractive field close to the nucleus to the region where the forces are repulsive, and may then obtain more kinetic energy than was required to upset its equilibrium. The disintegration of aluminium by bombardment with α-particles, where in some cases a proton is liberated with energy greater than that of the bombarding α-particle is an illustration of the above process. Blackett's photographs suggest that a bombarding α-particle is captured by an N nucleus, while the latter loses a proton. It may be that the same thing is true of aluminium, and the gain of energy mentioned above may come rather from the building up of a heavier atom than from disintegration into a lighter one. H. N. A.

1678. *Studies of Atomic Nuclei.* **E. Rutherford.** (Engineering, 119. pp. 437–438, April 10, 1925. Lecture delivered at the Royal Institution.)—A curve showing the observed proportion of particles deflected by silver plotted against the reciprocal of the energy of the α-particles 1/E shows agreement with the inverse square law; a similar result was obtained with gold and with uranium. With aluminium the above curve drops to a minimum when the energy of the particles increases, and then jumps up again as the energy increases further; the minimum corresponds exactly to the range of the α-particle at which protons are first shot out of the aluminium nucleus. This is explained by supposing that the aluminium nucleus consists of a central or inner nucleus, and a system of satellites, each of which may be a doublet. If an α-particle penetrates into the region of the satellites the force acting on it will be diminished, and the scattering will be reduced; if faster particles are used, which can penetrate completely through the field occupied by the satellites, the field of force reached would be much the same as outside the satellites, and the scattering will increase again. Blackett has photographed half a million tracks of α-particles through nitrogen and other gases; sixteen of these show collisions with nitrogen nuclei; in eight a proton was ejected, the faint track of which is visible in the photograph. The tracks of the α-particles after collision are not visible in the photographs, and it appears possible that the α-particle has been absorbed in the nucleus. H. N. A.

1679. *Atomic Disintegration due to α-Particles. Part II. Disintegration Products with Short Range.* **G. Kirsch** and **H. Pettersson.** (Akad. Wiss. Wien, Ber. 133. 2a. No. 5–6. pp. 235–241, 1925.)—Calls attention to the work of D. Pettersson, which shows that Radium C does not send out α-particles of ultra-normal ranges (7·5 to 13·3 cm.) as claimed by Bates and Rogers, and makes it theoretically possible to determine disintegration products with ranges over 9 cm. by ordinary methods; points out the difficulties that still exist, and describes a new method in which the particles projected at right angles to the direction of the original α-rays are observed. The ranges and numbers of the α-rays which are deviated in this direction for certain elements are estimated. The ranges in cm. in air are Li 1·0, C 2·5, Al 4·5, Au 6·6, so that with light elements the method is favourable to the observation of short-range disintegration products. In the latest form of the apparatus the α-rays from a small disc, activated with RaC, fall on the inner surface of a truncated cone, which is covered with the substance under investigation. A phosphorescent screen is placed in such a position that particles sent out at right angles to the α-rays from different points round the interior of the cone fall upon it, and produce scintillations. The screen is protected from the direct radiation from the RaC source by a small intervening disk of lead. H. N. A.

1680. *Ejection of Protons from Nitrogen Nuclei—Photographed by the Wilson Method.* **P. M. S. Blackett.** (Roy. Soc., Proc. 107. pp. 349–360, Feb. 2, 1925.)—Using a modified automatic Wilson expansion apparatus, the author has taken 23,000 photographs of tracks of α-particles in nitrogen, using a source of thorium B + C, emitting α-rays of ranges 8·6 and 5·0 cms. The average number of tracks on each photograph was eighteen; the tracks of about 270,000 α-particles of 8·6 cm. range and 145,000 of 5 cm. range have therefore been photographed. Amongst these tracks a large number of forks were found corresponding to the elastic collisions made by α-particles with nitrogen atoms. Analysis of the photographs shows that energy and momentum are conserved, at least approximately, during the collisions. But amongst these normal "forks" due to elastic collisions, eight have been found of a strikingly different type; these undoubtedly represent the ejection of a proton from a nitrogen nucleus. It was to be expected, under such circumstances, that the fork would exhibit three branches, whereas in fact these eight forks branch only into two. It appears therefore that the α-particle is captured by the nitrogen nucleus at the instant of emission of the proton. The significance of these important results is discussed in relation to recent work by Rutherford on the structure and disintegration of atomic nuclei. A. B. W.

1681. *Stopping Power of Gases for α-Particles.* **R. W. Gurney.** (Roy. Soc., Proc. 107. pp. 340–349, Feb. 2, 1925.)—By selecting small portions of the range the relative stopping-power of gases has been measured for α-particles of high velocity, of low velocity, and of intermediate velocity, separately. The gases examined were neon, xenon, krypton, argon, helium, hydrogen and oxygen. The values of the relative stopping powers tend to converge at the end of the range. The values for high velocities are in good agreement with the relative atomic stopping powers calculated from theory by Fowler [Abstract 2446 (1923)]. The measurements of ionisation in these gases, previously described, are discussed in the light of this result. A. B. W.

1682. *The Homogeneity of the Initial Velocities of the α-Rays from Polonium.* **Irène Curie.** (Comptes Rendus, 180. pp. 831–833, March 16, 1925.)—The experiments of the authoress on the range of polonium α-rays show differences between the ranges which are a little larger than those to be expected from the theory, and in the present paper she records the results of measurements of the difference between the initial velocities of these rays, using the magnetic deviation method. The width of the line produced on a photographic plate by the rays sent through two parallel slits, and afterwards deviated in a magnetic field, was measured and compared with that to be expected on geometrical grounds, taking into account various sources of error which can modify this width. In measuring the width it is necessary to define the intensity of the impression on the photographic plate as proportional to the number of rays received by it; the curve of variation of intensity is calculated on two assumptions: (*a*) the velocities are distributed about a velocity V according to a probability law with the coefficient ν; (*b*) the velocities are distributed uniformly between $V - \nu_1$ and $V + \nu_1$, where $\nu_1 = 1 \cdot 1\,\nu$, and it is found that although theoretically there is a great difference, the curve of intensity is for practical purposes the same in the two cases. The widening of the line depends on the ratio of the maximum intensity I, in the middle of the line, to the minimum intensity *i* observable in the microscope; and in the experiments the ratio I/*i* was determined by reversing the field and taking a short exposure, which gave a faint line on the other side of the plate. In one of the best plates I/*i* was estimated as about eight or ten, and there was no indication of any difference between the initial velocities of the α-rays of polonium; on the first of the above assumptions the extreme deviation is not as great as 0·3 %; on the second three-quarters of the rays have velocities which differ by less than 0·3 %. H. N. A.

1683. *The Acceleration of β-Particles in Strong Electric Fields, such as those of Thunderclouds.* **C. T. R. Wilson.** (Cambridge Phil. Soc., Proc. 22. pp. 534–538, March, 1925.)—A field of 10,000 volts per cm., in the direction of motion, will supply a β-particle, the velocity of which corresponds to 20,000 volts, enough energy to balance the average losses; one of 20,000 volts per cm., two-thirds of the sparking limit, will exceed the average loss by 10,000 volts per cm., and a particle will be accelerated until there is an exceptionally close encounter with an electron or nucleus. The mean rate of loss of energy varies inversely as the square of the velocity, so that the rate of loss of the accelerated particle constantly diminishes, approaching a limit of rather less than 1000 volts per cm. as the velocity approaches that of light. Even if the original direction does not coincide with that of the field, acceleration is possible if the component of the field in the direction of the velocity is large enough. It is shown that exceptional electron encounters have no important effect in preventing the acquisition of large kinetic energy in a strong field, and only direct encounters with atomic nuclei have such an effect. Such fields may exist in and about thunderclouds, where the whole potential difference may be of the order of 10^9 volts, and it seems possible that some electrons may gain energy approaching the equivalent of 10^9 volts; this is comparable with the energy Mc^2 of the hydrogen nucleus, which is the equivalent of 9×10^8 volts, so that the effective mass of the electron would be comparable with that of the H nucleus. There is some evidence of the existence of some extremely penetrating radiation in the atmosphere, and possibly some small portion of this may originate in the electric fields of thunderclouds. H. N. A.

HEAT.

1684. *The Thermal Expansion of some Binary Mixed Crystals.* **C. H. Johansson.** (Ann. d. Physik, 76. 5. pp. 445–454, April, 1925.) —This is an experimental contribution on the expansion of the systems Ag-Au, Cu-Ni, Au-Pd, Ag-Pd, Cu-Pd, and Cu-Au. The older measurements on amalgams and alloys at low temperatures have been summarised by K. Gilbert [Abstract 103 (1923)]. The coefficients of expansion were measured by the two-mirror method which has already been described [Abstract 2797 (1924)]. Some alterations in the apparatus are indicated with the help of a sketch. The results obtained are tabulated in four tables, and the coefficient of linear expansion as a function of the atomic percentage is exhibited graphically. The curves are all bent towards the axis of atomic percentage, and therefore give coefficients of expansion which are smaller than if the expansion were a function of the concentration. This may be due to the fact that when an atom of one component replaces an atom of the other in the lattice a deformation is produced so that the mean distance between the atoms is not proportional to the concentration. The influence of the different atomic volumes of the two components is briefly discussed. T. B.

1685. *Interior Ballistics.* **Gossot** and **Liouville.** (Comptes Rendus, 180. pp. 1014–1016, March 30, 1925.)—If c' is the capacity of the chamber, c the capacity of the whole bore and chamber, c_1 the capacity to the point of maximum pressure P, ν_1 the velocity at maximum pressure and ν at the muzzle, ω the mass of propellant of "force" f, δ the relation $\omega/(c'-\omega)$, m the mass of the shot and $1+2\gamma$ the ratio of the specific heats of the gas at the working temperature, then the relations

$$\left(\frac{c_1}{c}\right)^{1+2\gamma} = \frac{f\delta c'}{\mathrm{P}c}\left(1-\frac{m\gamma\nu^2}{f\omega}\right) \text{ and } 1-\frac{m\gamma\nu_1^2}{f\omega} = \frac{\mathrm{P}c}{f\delta c^1}\cdot\frac{c_1}{c}$$

can be shown to be independent of the relation between pressure and the rate of burning, independent of the "form" of the propellant and only affected by such matters as cooling of the gas, non-uniform gas density or experimental errors. It also supposes that the maximum pressure coincides with the point of complete combustion of the charge. If this does not hold, the equations apply to this point rather than to the point of maximum pressure. A series of experimental data obtained in 1904 with somewhat crude spring pressure gauges are applied to this theory. It is found that a certain correction to the observed pressure enables the capacity and velocity at maximum pressure to be brought into line with observation. This leads to a value for the ratio of the specific heats between 1·256 and 1·300. This value seems very reasonable. A. Wh.

1686. *The Measurement of the Ratio of the Specific Heats using Small Volumes of Gas. The Ratios of the Specific Heats of Air and of Hydrogen at Atmospheric Pressure and at Temperatures between 20° C. and – 183° C.* **J. H. Brinkworth.** (Roy. Soc., Proc. 107. pp. 510–543, March 2, 1925.) —Values of $\gamma(=C_p/C_v)$ for air and hydrogen at temperatures between 20° C. and – 183° C. have been determined by observation of the cooling effect accompanying adiabatic expansion of the gases in bulbs of volumes ranging from 697 c.c. to 11·2 c.c. A linear relation was found to exist between the reciprocal of the cube root of the volume of the bulb and the value of γ directly determined. The correct value of γ has been ascertained by extrapolation of the results, by means of this relation, the value corresponding to a bulb of infinite volume being deduced in this manner. Values of γ as follows were found at the temperatures (° C.) stated: Air: 17°, 1·4032; − 78°, 1·4077; − 118°, 1·4154; hydrogen: 17°, 1·4070; 0°, 1·4099; − 21°, 1·4200; − 78°, 1·4427; − 118°, 1·4800; − 183°, 1·6054. Previous measurements of γ by Moody, Shields, Lummer and Pringsheim, Makower, Mercer, Partington are critically discussed. Values of S_v for hydrogen at 252° and 273° (abs.) agree within 1 part in 250 with experimental results. Callendar's formula for the variation of S_v with temperature is, of formulæ hitherto proposed, in closest agreement with the author's results. [See Abstract 1690 (1914).] J. S. G. T.

1687. *Specific Heats of Carbon Monoxide and Hydrocyanic Acid Vapour.* **J. R. Partington** and **M. F. Carroll.** (Phil. Mag. 49. pp. 665–680, April, 1925.)—The preparation and purification of the two gases experimented upon are described in detail. The method employed for the determination of their specific heats, a modification of that of Behn and Geiger, depends upon the relative velocities of sound in these gases and in air, as described in a previous paper [see Abstract 1419 (1923)]. The expected values for the specific heats of CO are confirmed. At 10·3° C., 760 mm. pressure, $C_p = 6{\cdot}94$ cals., $C_v = 4{\cdot}94$ cals., $\gamma = C_p/C_v = 1{\cdot}404$. Provisional values are obtained for HCN; at 20·8° C., 422 mm. pressure, $C_p = 9{\cdot}69$ cals., $C_v = 7{\cdot}56$ cals., $\gamma = 1{\cdot}282$; at 17·35° C., 505 mm. pressure, $C_p = 10{\cdot}22$ cals., $C_v = 8{\cdot}08$ cals., $\gamma = 1{\cdot}268$.

A. B. C. L.

1688. *Specific Heat of Superheated Ammonia Vapour.* **N. S. Osborne, H. F. Stimson, T. S. Sligh, Jr.,** and **C. S. Cragoe.** (Bureau of Standards, Sci. Papers, No. 501. pp. 65–110, 1925. Abstract.)—Measurements of the specific heat at constant pressure of superheated ammonia vapour within the range of temperature and pressure ordinarily used in refrigeration, and of the Joule-Thomson effect to evaluate certain small correction terms.

1689. *Limits for the Propagation of Flame in Inflammable Gas-Air Mixtures. Part III. The Effect of Temperature on the Limits.* **A. G. White.** (Chem. Soc., J. 127. pp. 672–684, March, 1925.)—Results obtained for the limits for the propagation of flame downward in tubes 25 mm. in diameter at various temperatures up to 400° in the case of mixtures of hydrogen, carbon monoxide, methane, ethylene, acetylene, and pentane with air agree with previous results for the lower limits of methane in air [see Abstract 600 (1925)], but do not accord with any of the upper-limit results in the literature. The temperature-lower-limit curves obtained are very nearly straight lines, the limit figure falling by from 6 to about 8 % per 100°. Similar curves for the upper limits are also straight lines in certain cases, but for ethylene and acetylene the upper-limit figures increase very rapidly at the higher temperatures. Calculation shows that at the lower limit, for all the gases except hydrogen, the theoretical flame temperature remains approximately the same throughout the whole temperature range. It is concluded that the propagation of flame is not much influenced by the ignition temperature. It is found in the case of methane-air mixtures that the limits determined in a narrower tube increase less rapidly with temperature than those in a wider tube. For the same gas mixture approximately the same results are obtained for horizontal as for downward propagation. J. N. P.

1690. *Thermal Diffusion Measurements.* **T. L. Ibbs.** (Roy. Soc., Proc. 107. pp. 470–486, March 2, 1925.)—It was shown in a previous paper [Abstract 1999 (1921)] that when a mixture of carbon dioxide and hydrogen was passed through a separating device consisting of a glass tube with a platinum wire helix, heated by a current, in the middle, and the gas drawn off in two streams, one near to the hot helix and the other from the cooler outer parts of the tube, there was a tendency for the heavier carbon dioxide molecules to move towards the cold side, and the hydrogen molecules to move towards the hot side. Analyses of the gas mixtures were made by means of a differential katharometer. Further experiments were made to investigate the phenomenon of separation of mixtures of different pairs of gases under definite temperature conditions. Five pairs of gases were investigated: hydrogen and carbon dioxide, hydrogen and nitrogen, nitrogen and carbon dioxide, hydrogen and argon, helium and argon. The separation was found to be nearly proportional to $\log T_1/T_2$. F. J. B.

1691. *Trouton's Law at the Absolute Zero of Temperature.* **N. Perrakis.** (Comptes Rendus, 180. pp. 579–580, Feb. 23, 1925.)—Trouton's law states that the ratio of the molecular heat of vaporisation L to the absolute temperature of the boiling-point T, at normal pressure, is a constant. In rare gases it is shown that L/T is not constant, but at low temperatures decreases progressively. It seems as though the Trouton ratio L/T tends towards a definite limit as T approaches zero, and this is expressed $L/T = \phi[T]$. This is of the dimensions of an entropy, and is the entropy at the boiling-point. The ratio L/T varies as a function of the temperature, notably at low temperatures, and this variation is expressed by an equation of the form $L/T = \phi[T] = S_0\epsilon^{a\cdot T^{m}}$, where $S_0 = 3/2R = 2\cdot 98$ cal./deg. S. G. B.

1692. *The Cooling of Hot Bodies in Gases and Liquids.* **R. Seeliger.** (Phys. Zeits. 26. pp. 282–295, April 2, 1925.)—This comprehensive paper deals at length with previous work and with the hydrodynamical and gas layer theories, including a comparison of theory and experiment. The present condition of knowledge is that the cooling of a hot body in a liquid or gas is regarded as taking place so that heat from the cooling medium is conducted away according to the expressions of the classical theory of thermal conduction, whereby, however, the medium, in consequence of the temperature differences, is not static, but circulates in convection currents around the hot body according to the laws of hydrodynamics. For a practically unlimited medium the differential equations which describe this complex mechanism, while not admitting of rigid solutions, lead, however, to the derivation of very useful models which reveal the mechanism as derived from general dimensional considerations. First approximations show on the one hand a certain degree of agreement with Boussinesq that inner friction of the medium may be neglected and that its physical properties do not depend on temperature, and on the

other with Langmuir that only the thermal conduction plays a part, the medium behaving as though at rest near to the hot body. A second approximation shows agreement with Davis that inner friction and temperature dependence have to be taken into account, thereby extending the approximations of Boussinesq and Langmuir. The latter assumptions, however, have to be greatly supplemented at high temperatures and low pressures. According to Langmuir, they depend on abrupt temperature changes at the surface of the hot body and on the thermal effect of a partial gaseous dissociation. Cooling in a circumscribed medium is at present still very obscure, and best explained by the Langmuir standpoint.
H. H. Ho.

1693. *Representation of the Haber Equilibrium Data by an Equation.* **L. J. Gillespie.** (J. Math. Phys., Mass. Inst. of Technology, 4. pp. 84–96, April, 1925.)—The value of the equilibrium constant K_p referring to the equilibrium between nitrogen, hydrogen and ammonia, is shown empirically to be related to the pressure p (up to 100 atmos.) and the temperature T° abs. (between 598° and 773° abs.) by the equation $\log_{10} K_p = (2679 \cdot 35 + 1 \cdot 1184\, p) 1/T - (5 \cdot 8833 + 0 \cdot 001232 p)$. For higher pressures up to 1000 atmos. the equation takes the form $\log_{10} K_p = (2172 \cdot 26 - 1 \cdot 99082\, p) 1/T - (5 \cdot 2405 + 0 \cdot 0021550 p)$. A discontinuity prevents high and low pressure data being both represented by a single equation. A similar discontinuity exists between the data of Larson and Dodge and those of Haber at 30 atmos. Both discontinuities are attributed to a variation in the composition of the mixture of gases, and it is concluded that K_p depends upon internal variables determined in accordance with the phase rule.
J. S. G. T.

1694. *The Motion of Free Electrons in Black Body Radiation, and the Interaction between Radiation and Matter.* **G. Breit.** (Phil. Mag. 49. pp. 537–565, March, 1925.)—It is generally supposed that the correct value for the mean kinetic energy of free electrons in black body radiation is 3/2KT. On the assumption that the waves constituting black body radiation have random phases, Fokker showed that the mean kinetic energy of the electron's motion is only about 1/24 of the above value. Pauli on the quantum theory obtains 3/2KT. The present situation is therefore such as to condemn the classical wave theory in favour of the light-dart theory from considerations based on the motion of free electrons alone. The author re-examines this evidence in favour of light-darts, and concludes that: (1) The equations of motion of an electron in its orbit are to a first approximation classical, provided the radiation force $2e^2\ddot{v}/3c^3$ and the wave force $ed + e[vh]/c$ are disregarded. (2) The electron leaves its quantised state and passes into a state of higher or lower energy if the amount of work done on it by either of the neglected forces (or perhaps both) is equal to the energy difference between these states. The forces are regarded as acting on a collection of equivalent resonators which represent the mean motions of the electron between various quantised states. (3) Besides the function of determining probabilities of transition between quantum states, each of the equivalent resonators of frequency ν_0 acts on incident wave of frequency ν as though it were a classical resonator. Thus the classical wave theory, if given proper attention, is not powerless in dealing with phenomena for which light-quanta have been especially devised.
T. B.

1695. *The Quantum Theory of Thermal Radiation.* **J. K. Syrkin.** (Zeits. f. Physik, 31. 11. pp. 836–843, 1925.)—Considers the radiation quanta as analogous to the molecules of a vapour, and as vaporising from the hot body which emits them until equilibrium results. The quanta inside the hot body are regarded as in a state of bound "potential"; this additional assumption, together with that of distribution according to the probability law, gives the value of the density of black body radiation. Using the ordinary laws of the kinetic gas theory, expressions are found for the pressure, the energy density in the space through which the quanta pass, and the mean energy of a quantum; this is found to be twice as great as the mean energy of an ideal monatomic gas, and it appears that the quantum must have six degrees of freedom. An expression is derived for the law of distribution of the quanta according to frequency, or for the number of quanta with frequency between ν and $\nu + d\nu$. To obtain Planck's law it is necessary to assume the existence of quantum aggregates, made up of whole numbers of quanta, so that instead of $h\nu$ the quantity $ih\nu$ appears in the formulæ, where i varies from 1 to ∞. H. N. A.

1696. *The Proof of the Corollary of Carnot's Theorem.* **A. E. Ruark.** (Phil. Mag. 49. pp. 584–585, March, 1925.)—Many methods exist for proving by the use of the first and second laws of thermodynamics the theorem that "all reversible engines working between the same temperatures have equal efficiencies." The author now points out that this statement may be derived by using the first law together with a postulate, which denies the validity of the second law and which the author writes in the form: "It is impossible for any self-acting mechanism working in a complete cycle to produce work continuously by transferring heat from a higher to a lower level of temperature without producing any other effect." H. H. Ho.

1697. *Entropy and State Probability of the Perfect Gas.* **F. v. Hauer.** (Phys. Zeits. 26. pp. 281–282, April 2, 1925.)—Under the sole assumption of the Maxwell distribution law, it is shown that the probability of a gas receiving definite values of temperature and volume when in thermal exchange with a gas reservoir at enormously high temperature is connected with the entropy of the gas by the Boltzmann equation. This result cannot be gathered either from the original or from the generalised form of the Boltzmann equation. H. H. Ho.

1698. *Reply to Criticisms of F. Simon on "Entropy of Condensed Gases."* **A. Eucken** and **F. Fried.** (Zeits. f. Physik, 32. 2. pp. 150–158, 1925.)—The criticisms of Simon on the estimate of the errors and on the reliability of the train of reasoning from the results is examined in detail and shown to be inconclusive. By consideration of the different possibilities an explanation is given of the deviations from the customary form of the Nernst heat relation, which is stated as better than that of Simon's. By a further examination of the values obtained at the Leyden laboratory by direct measurement at low temperatures and those obtained by the thermodynamical method the authors decide against a modification of the numbers given earlier for the heat of vaporisation and the integration constant i for H_2. [See Abstract 1438 (1925).] R. S. R.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

1699. *The Electromagnetic Laws and the Quantum Theory.* **H. A. Senftleben.** (Zeits. f. Physik, 31. 7–8. pp. 627–636, 1925.)—Assuming the Lorentz equations for the electromagnetic field in empty euclidian space, the author attempts to formulate laws which will also include the quantum theory. The "magnetic" field equations are assumed to hold throughout the whole of space, while the "electric" ones hold also, except in small spaces about the singular points, the sources and sinks corresponding to the charges, which must be regarded as outside the electromagnetic field. The conservation laws of the field are retained (energy and impulse) and the cases of a single quantum of charge at rest and of the same charge in uniform motion are first dealt with. A free molecule is treated in terms of the Bohr theory. The molecule must be regarded as separated from the field of radiation outside it, and in addition to this a region containing a point of singularity, which region may be spoken of as the source, is to be regarded as separated from the field. Such magnitudes as energy, impulse, rotational impulse can pass from the molecule in quanta, and suddenly, into the source, but not directly into the outside field; while the transition from source to radiation field takes place as a train of waves, so that the source forms a reservoir which, averaging over a considerable period, neither gains nor loses any of the above magnitudes. In a diagram the molecule is indicated by a circle representing a sphere, and the source is represented by a smaller concentric circle (sphere); arrows indicate the passage of the quanta into the source from the molecule, while others indicate the passage of waves from the source outward through the molecule into the surrounding field. The effect of diminishing the constant h is discussed, and it is shown that in the limit when $h = 0$ all the results of the Lorentz theory are obtained; it is also possible to obtain Minkowski's differential equations by neglecting the molecular structure of matter. H. N. A.

1700. *Motion of an Electric Charge.* **A. Bramley.** (Phil. Mag. 49. pp. 912–923, May, 1925.)—The relation of the charge to the electric and magnetic field is based on the experimental relations

$$\int \mathrm{H}x\,dx + \mathrm{H}y\,dy + \mathrm{H}z\,dz = \iint (\rho v + d\mathrm{E}/dt)_n\,d\mathrm{S},$$

and

$$\int \mathrm{E}x\,dx + \mathrm{E}y\,dy + Ez\,dz = -\iint (d\mathrm{H}/dt)_n\,d\mathrm{S},$$

where ρv is the electric flux through the surface at any point, n denotes the normal component, each line integral is taken over any particular closed curve, and the corresponding surface integral over any surface bounded by this curve. If then ρv is known as a continuous function of position at any particular instant t, the above equations assume the form $\rho u + \partial \mathrm{E}_x/\partial t = \mathrm{curl}_x\,\mathrm{H}$, and $-\partial \mathrm{H}_x/dt = \mathrm{curl}_x\,\mathrm{E}$, where u is the component along the x-axis. But Einstein pointed out [Abstract 222

(1924)] that these equations define a relation between field and charge at any instant, but do not correlate the different images of the electromagnetic phenomena at instants t and t'. Now in a space-time $ds^2 = dx^2 + dy^2 + dz^2 - dt^2$ the fundamental integrals, and hence Maxwell's equations, refer to any space-like variety $ds^2 = dx^2 + dy^2 + dz^2$, obtained as a section perpendicular to the time-axis, so that ρv will be a function of position in any one variety $t = t_0$, $(\rho v) = f(x, y, z, t)$, and is therefore expressible as a function of position in this space-time. Then if there be no singularities, e.g. point-charges, in the field the flux can be expanded in the form $(\rho u) = (\rho u)_0 + (\rho u)_1 t + (\rho u)_2 t^2 + \ldots$. Similarly E and H are expressible in the forms $E = E_0 + E_1 t + E_2 t^2 + \ldots$ and $H = H_0 + H_1 t + H_2 t^2 + \ldots$, where H_0, E_0, H_1, E_1, etc., are functions of x, y, and z only, and where E and H represent any one of the three components E_x, H_x, etc., the distribution of charge and velocity being such that the series are convergent. It is then easily seen that all subsequent coefficients are determinable from the values of E_0 and H_0, when these are the values of the two field intensities at a particular instant when $t = 0$. Kirchhoff's classical solution of Maxwell's equations is discussed, from which it is seen that it can only be regarded as a fictitious solution which contains no energy. Instances of fictitious gravitational fields have been pointed out by Eddington, and Bohr [Abstract 2065 (1924)] has developed the consequences of the idea applied to electromagnetic theory. The most general motion of a charge radiating no energy, but under the influence of Maxwellian forces, and also a resisting force proportional to the velocity is investigated, tensor methods being employed. The consideration of the most general motion of an electric charge without radiation of energy leads to the conclusion that the motion is periodic only when Σ action $= nh$, where n is an integer and h is a constant, the action integrals being taken over a complete cycle. The quantum conditions for periodic orbits are a particular case of this more general condition. G. W. de T.

1701. *The Ampère Trough Experiment.* **F. W. Grover, J. P. Das and J. H. Turnbull.** (Frank. Inst., J. 199. pp. 395–404, March, 1925.)—The authors, in view of C. Hering's contentions [see Abstract 1455 (1923)], describe a very thorough mathematical and experimental examination, making use of extremely sensitive apparatus, of Ampère's Trough Experiment. The result was to obtain conclusive demonstration that analysis founded on the accepted electromagnetic laws accounts for the experimental facts. G. W. de T.

1702. *Waterfall Electric Carrier-formation with Pure Water and Salt Solutions. Their Surface Conditions.* **W. Busse.** (Ann. d. Physik, 76. 5. pp. 493–533, April, 1925.)—After a short introduction the subject is dealt with as follows: Size distribution of negative and positive carriers generated by scattering distilled water; deciding the question whether groups of carrier-sizes are present; consideration of the travelling velocity formula; the origin of positive carriers in pure water; size and quantity of positive carriers generated by scattering in dependence on pressure; the positive carrier formation with bubbling action; carriers generated by solutions of common salt; the sign of the charge with carriers containing sodium; size of carriers and quantity of electricity developed in dependence upon the concentration; the surface conditions of salt solutions. A. E. G.

DISCHARGE AND OSCILLATIONS.

1703. *Flame Tension and Stability of the Intermittent Glow-Discharge.* **H. Geffcken.** (Phys. Zeits. 26. pp. 241–253, March 1, 1925.)—A special method of investigating the intermittent glow-discharge is described, the essential feature of the method being the introduction of a glow-kathode tube before the discharge tract. The flame tension of the discontinuous glow discharge in air at pressures 0·2 mm. to 1·5 mm. Hg is observed. The change from the intermittent to the continuous glow-discharge is investigated. It is shown that with increasing parallel capacity the current value of the abnormal continuous glow-discharge approximates asymptotically to that of the normal continuous glow-discharge. A. E. G.

1704. *Reactions in Mercury Vacuum Arc.* **A. Güntherschulze.** (Zeits. f. Physik, 31. 7–8. pp. 509–513, 1925.)—Previous work of the above author and Langmuir [see Abstract 618 (1924)] has shown that the potential at a point in a discharge through gas can only be measured by the "explorer" when the velocity of the electrons at this point can be neglected. A balance-sheet of the energy for the kathode shows that, at the kathode, the current is practically entirely carried by kations. From a consideration of the energy absorbed and evolved at the kathode, the equation $(1 - x)(y + 7\cdot 1) = 3\cdot 9x + 4\cdot 92$ is developed, where x is the fraction of each ampere transported by electrons and $(1 - x)$ by the kations. When the equation is solved, the values $x = 0\cdot 55$ and $y = 8\cdot 6$ volts. The value for y is considerably higher than that found by Stark, *viz.* 5·27 volts. The energy given up at the anode by radiation per ampere is 7·34 watts. The energy supplied to the anode per ampere for a fall of V volts is V watts. The neutralisation energy of the electrons is 3·9 watts, and hence $V + 3\cdot 9 = 7\cdot 34$, whence $V = 3\cdot 44$ volts. F. J. B.

1705. *On a Relationship between the Work of Dissociation of Electrons and the Electro-chemical Normal Potential.* **A. Güntherschulze.** (Zeits. f. Physik, 32. 3. pp. 186–189, 1925.)—In a previous paper [see Abstract 604 (1924)] the author has shown that a relationship exists between the electrochemical normal potential of metals and the normal kathode fall. Now by means of observation data (included in the paper) he shows that a very close empirical relationship exists between the work of dissociation ϕ_{el} of electrons and ϵ_p, the electro-chemical normal potential of metals, the quantity $1\cdot 3\,\phi_{el} - \epsilon_p$ being found practically a constant for thirteen metals, with the average deviation $\pm 2\cdot 5\%$. The metals for which very concordant data exist are K, Na, Ba, Ca, Mg, Al, Ni, Fe, Cd, Hg, Sn, Cu. Exceptions are Ag, Pb, and Li (the most extreme). H. H. Ho.

1706. *A Pseudo High Vacuum.* **A. Güntherschulze.** (Zeits. f. Physik, 31. 7–8. pp. 606–616, 1925. From the Reichsanstalt.)—A number of experiments on a pseudo high vacuum lead to the conclusion that neither alterations of the electrodes nor the gases are the cause of pseudo high vacua, but that the cause is probably statical charges on the walls of the vessel. The paper is divided into two sections: in the first, the production of a pseudo high vacuum is described; in the second, the cause of the phenomenon is discussed. A. E. G.

1707. *Radiation given out by Gases through which Electric Discharges are Passing.* **J. J. Thomson.** (Phil. Mag. 49. pp. 761–786, May, 1925.)—In a paper on the electric discharge through gases at low pressures [see Abstract 3031 (1924)] the author gave reasons for thinking that the ionisation in the " negative glow " is due to radiation excited by the kathode rays in the gas through which they pass. The present paper contains an account of a series of experiments made with the object of obtaining direct evidence of the existence of this radiation and of throwing some light on its properties and origin. This radiation is not penetrating enough to pass through the glass of the discharge-tube, so that to study it some method must be used by which it can be detected inside the tube, or, at any rate, before it has had to pass through an appreciable thickness of solid matter. The most sensitive methods for detecting such radiations depend on the electrical effects, such as those of ionisation or of photoelectricity, which they produce. As the electrical discharge fills the tube with ions which would disturb any electrical detector of the radiation if they came into contact with it, it is necessary to screen off the ions from the detector. Three kinds of screens are used here: the first a material screen of very thin celluloid; in the second there is no solid matter between the detector and the gas in the tube, but the ions are screened off by a strong electrostatic field; in the third type of screen the electrostatic field is replaced by a magnetic one. An account is here given of experiments on the radiations inside a closed vessel containing gas at a low pressure through which an electric discharge is passing. It is shown that when electrons pass through gases, Röntgen rays are produced which may be of far higher frequency than any of the characteristic radiation of the gas. Thus, when electrons produced by a p.d. of 1500 volts are passed through hydrogen, Röntgen radiations having a frequency corresponding to 1500 volts are found. The spectrum appears to be a continuous one with its maximum frequency proportional to the energy of the electrons. Some of this radiation is absorbed by gases with remarkable rapidity; thus, for example, radiations are detected in the tube which are absorbed in 2 or 3 cm. of air at the pressure 0·01 mm. of Hg. Absorption as great as this shows that the volume in which the energy of this type of radiation is concentrated must be considerably larger than the volume of a molecule of the gas. It is shown that there is some regular reflection of the radiations from a polished metal surface, the maximum amount of reflection obtained being about 5 %. An expression is arrived at for the distribution of energy in the continuous spectrum produced when electrons pass through a gas. A. E. G.

1708. *Influence of Pressure on the Band Spectra of Carbon. Consequences for the Theory of Comets.* **F. Baldet.** (Comptes Rendus, 180. pp. 1201–1203, April 20, 1925.)—When the pressure of carbon moxoxide contained in a bulb with an incandescent kathode is changed, the spectra of the gas are modified. [See Abstract 1877 (1924).] The heated kathode emits electrons which ionise the gas, but other types of collision are possible. Thus at very low pressures, when the electronic collisions predominate the first and third negative groups alone are visible, while at higher pressures, when the effective number of molecular collisions is larger, the spectra are enriched by the positive group. Changes are also observed, with pressure, in the structure of the bands. These results agree with a theory put forward by Deslandres in 1895, with respect to corpuscular emission from the sun. According to this theory the sun projects kathode rays to great distances, and it is thought that the oxycarbonic and ultra-rarefied gases contained in comets are probably illuminated by collision with electrons coming from the sun. This seems the more likely, as the spectra are very sensitive to changes of pressure, presence of foreign gases, and different conditions of excitation, yet the identity between the observed spectra and those of comets is complete. The spectra are the same, so far as can be observed with the feeble dispersions employed in the observations on comets, whether the velocity of the electron corresponds to 16 volts or 50,000 volts. W. V. M.

1709. *Point Discharge and Electric Wind.* **W. Deutsch.** (Ann. d. Physik, 76. 7. pp. 729–736, May, 1925.)—The point discharge and the spectrum of the rays emitted have lately been the subject of investigation [see Abstract 1599 (1920)]. In the present paper the sharp imprint of the outer edges of the dust figure is seen in the radial diminution of the wind velocity in conjunction with the electric field of force at the ground surface of the point current. It is shown that, with higher tensions, not only the point itself, but also the surrounding part of the point have an essential share in the discharge, which is the cause of the dust being deposited in several ring-formed layers. The paper is illustrated with diagrams and photographs. A. E. G.

1710. *Absorption in Excited Neon. Remarks on the Work of K. W. Meissner.* **P. Jordan.** (Zeits f. Physik, 31. 11. pp. 877–881, 1925.)—The Meissner result on the different lengths of life of 1Si-condition with neon are understandable if the number of quanta of the fundamental conditions are determined in a suitable manner. For the theoretical determination of these quanta numbers the Landé-Heisenberg ramification composition is not sufficient; the correct result is obtained by referring to the theory of the periodic systems. [See also Abstract 1188 (1925).] A. E. G.

1711. *Electromagnetic Analysis of Canal Rays.* **R. Döpel.** (Ann. d. Physik, 76. 1. pp. 1–28, Jan., 1925.)—Positive rays are more complex than kathode rays in respect of both velocity and mass, and it is therefore of importance to consider the distribution of both these quantities among the particles. In the present paper a description is given of investigations of the velocity distribution in hydrogen in its relation to voltage and gas-pressure. The usual parabolæ are obtained and quantitative measurements of the energy distribution made by the help of a manganin-constantan thermocouple placed near a Willemite screen. The velocity of the particles increases proportionally to the square root of the voltage, and the electromagnetic energy curves for hydrogen canal rays produced in a cylindrical tube show, analogously to the results with oxygen, three maxima for positive particles whose deviations are approximately in the ratios of $1 : \sqrt{2} : 2$. These are ascribed to molecules, and quick and slow atoms. The negative energy curves show only atoms, the negatively changed molecules having little stability. The velocity distribution does not depend on the current strength. It does, however, depend on (*a*) the pressure of the gas (increased pressure decreases chiefly the slow atoms); (*b*) the voltage (with increasing voltage the molecules and slow atoms are much weakened and the ratio between positive and neutral particles is increased); (*c*) admixture of other gases and the form of the discharge tube; (*d*) the dimensions of the "canal." The curves, deduced from the energy curves, and showing the numbers of different types of particles, show that for hydrogen they consist chiefly of slow atoms. The addition of oxygen to the hydrogen causes a relative increase in the number of molecules; the ratio of charged particles of hydrogen and oxygen in the canal depends somewhat on the voltage and agrees roughly with the partial pressures. Canal rays produced in a spherical tube contain relatively more molecules than in a cylindrical tube. Beside the known particles (H_3^+, H_2^+, H^+, H^-, He^+) a negative hydrogen molecule, a negative helium atom, as well as the atomic parabolæ and those of the molecules of H_2, O_2, N_2 and the atomic curve of He are observed, these being evidence of H_4, O_4, N_4 and He_2 existing in the dark space.

W. V. M.

1712. *The Excitation and Ionisation Potentials of the Inert Gases.* **G. Hertz** and **R. K. Kloppers.** (Zeits. f. Physik, 31. 7–8. pp. 463–469, 1925.)—This paper describes the measurement of the excitation and ionisation potentials of argon, krypton and xenon. For krypton and xenon [see also Abstract 943 (1924)] several discrete excitation potentials were found, as in Hertz's earlier work on neon and argon [see Abstract 1931 (1923)], these probably not indicating separate spectral terms, but groups of such near together. A simple construction for an equipotential glow kathode is included. Results:—

	Helium.	Neon.	Argon.	Krypton.	Xenon.
Excitation potential, volts	2*s* 19·77 2*s* 20·55	(2*s*) 16·6 (2*p*) 18·5	11·5 13·0 13·9	9·9 10·5 11·5 12·1	8·3 9·9 11·0
Ionisation potential, volts	24·5	21·5	15·4	13·3	11·5

H. H. Ho.

1713. *The Equilibrium of Ionisation in the Atmosphere.* **J. J. Nolan, R. K. Boylan,** and **G. P. de Sachy.** (Roy. Irish Acad., Proc. 37. pp. 1–12, April, 1925.)—In this paper some results are presented from a general investigation of atmospheric ionisation, nucleation, and kindred phenomena. Previous work is referred to. [See Abstract 596 (1924).] It is found that: (1) the large ions in the atmosphere carry single electronic charges. (2) A constant fraction of the nuclei of the atmosphere is charged, *i.e.* is large ions. The ratio of the uncharged nuclei to the large ions of one sign is 1·28 approx. (3) The equilibrium between large and small ions in the atmosphere is determined by the equation $q = \alpha n^2 + 2\eta_2 Nn$, where α is the ordinary recombination coefficient for small ions and η_2 is the recombination coefficient between small and large ions of the opposite sign. When large ions are plentiful the relation is $q = 2\eta_2 Nn$. The value of η_2 is $9{\cdot}7 \times 10^{-6}$. (4) A close relation exists between the atmospheric potential gradient and the concentration of nuclei (and therefore of large ions) in the air. Experimental details with data and curves are included.

H. H. Ho.

1714. *Ionisation by α-Particles in Monatomic and Diatomic Gases.* **R. W. Gurney.** (Roy. Soc., Proc. 107. pp. 332–340, Feb. 2, 1925.)—

Measurements have been made of the total ionisation produced by definite beams of α-particles in the five monatomic gases He, Ne, Ar, Kr, and Xe and in the diatomic gases H_2, N_2 and O_2. In the five rare gases the ionisation increases with increasing atomic number, which would be expected from their decreasing ionisation potentials. In the diatomic gases, however, the ionisation is less than in any of the monatomic gases, indicating that energy is expended in other ways. The ratio of the value of the ionisation in air to that in the other gases is found to vary with the velocity of the α-particles. A. B. W.

1715. *Ionisation of Iodine Vapour by Ultra-violet Light.* **W. West** and **E. B. Ludlam.** (Roy. Soc. Edinburgh, Proc. 45. 1. pp. 34–41, 1924–1925.)—The experimental results here described indicate that iodine vapour is ionised by light in the extreme ultra-violet, radiation of longer wave-length than 185 $\mu\mu$ being inactive. As fluorite itself begins to absorb in the neighbourhood of 120 $\mu\mu$, it is probable that intensity of any radiation of shorter wave-length than this would be too feeble to produce any appreciable effect in these experiments. As these experiments are carried out at ordinary temperatures there would be very few atoms primarily present, but the possibility of the dissociation of molecules by the radiation must not be overlooked. Keeping, however, to known facts, it is seen that normal iodine molecules would just be ionised by the radiation at 130 $\mu\mu$. It is, however, probable that longer wave-lengths than this will produce ionisation of iodine molecules. It is concluded that the conductivity observed is due to the ionisation of molecules by light of wave-length shorter than 180 $\mu\mu$, and, as in the present experiments many of the molecules might be expected to be in the state of fluorescence, it is probable that these contributed the greater share. A. E. G.

1716. *The Mobility of the Positive Ions in Air.* **H. B. Wahlin.** (Phil. Mag. 49. pp. 566–570, March, 1925.)—The object of the work was to determine whether ions having mobilities lower than the value ascribed to the normal ion could exist in air. The method used was the Franck-Rutherford alternating-current method [see Abstract 194 (1923)]. Polonium was used as an α-particle source, and the procedure was the usual one of measuring the charge received by the collecting plate in a given time for different values of the alternating potential. A curve of the current against alternating voltages is plotted, and the mobility determined from this. Curves obtained showed sharp breaks indicating that more than one type of ion, each with a different mobility, was present. The mobility K was determined from the relation $K = \pi n d^2 P/\sqrt{2}\,.\,V\,760$, where d is the distance between gauze and collecting plate, n is the frequency, V the effective value of the alternating voltage, and P the pressure in mm. The mobilities observed, together with corresponding values previously given by Erikson and Nolan, were :—

Nolan	1·79	1·52	1·37			
Erikson	1·89	—	1·35			
Wahlin	1·89	1·57	1·35	1·20	1·10	0·97

T. B.

1717. *Electron Emission from Tungsten, Molybdenum and Tantalum.* **S. Dushman, H. N. Rowe, Jessie Ewald** and **C. A. Kidner** (Phys. Rev. 25. pp. 338–360, March, 1925.)—Measurements of thermionic emission as a function of the temperature are made by means of a thoroughly exhausted tube containing a long **V**-shaped filament with an anode consisting of a calcium surface deposited on the wall. The data obtained are corrected for lead losses and for the Schottky-effect. In the case of pure tungsten, the results for a number of filaments agree well with each other and with the equation $I = AT^2e^{-b_0/T}$, where, if I is in amp./cm², A has the value 60·2 or $\log_{10} A = 1{\cdot}779$ and $b_0 = 52{,}600 \pm 250$, which is in good agreement with previous results. With tantalum, the accuracy of the results is not as great, because of uncertainty as to the temperature scale, but the indication is that the value of A is the same as for tungsten. With molybdenum, the variation in the results for different experiments indicates that the surfaces were not sufficiently cleaned and were contaminated with oxide, which would tend to raise the value of A. The mean value of $\log_{10} A$ obtained is about 2·2. It is pointed out that theoretically A can be expected to be a universal constant only for surfaces for which the surface heat due to positive charge is zero. Experiments with coated filaments show that electronegative atoms like oxygen increase A and electropositive elements like thorium and cæsium decrease A. [See Abstract 310 (1924).] J. N. P.

1718. *The Glow Electronic Emission at the Transformation and Melting-points.* **A. Goetz.** (Phys. Zeits. 26. pp. 206–207, Feb. 15, 1925.)—In an earlier paper [see Abstract 605 (1924)] the author has described the course of the electronic emission as a function of the kathode temperature, which is represented by a straight line on the assumption of certain constants. Deviations above the melting-point caused the author to state that the work of emission had then increased. This has now been shown incorrect, the work being actually less. The Richardson emission equation is consequently found inadequate to explain this deviation of the emission lines above and below the fusion-point, and the conclusion is drawn that the original relationship fails to hold good. A brief discussion of the discontinuity is then given. H. H. Ho.

1719. *Action of Light on the Thermionic Effect.* **E. Henriot** and **R. Moens.** (Comptes Rendus, 180. pp. 651–653, March 2, 1925.)—The sound effects produced in a telephone suitably connected with an incandescent tungsten filament acted upon by a beam of light interrupted by a toothed wheel are recorded. The results are regarded as indicating the purely thermal effect thus obtained. A. B. C. L.

1720. *The Thermionic Work-functions and Photoelectric Thresholds of the Alkali Metals.* **O. W. Richardson** and **A. F. A. Young.** (Roy. Soc., Proc. 107. pp. 377–410, March 2, 1925.)—A summary of the previous knowledge is given. Attention is drawn to existing evidence that the thermionic work function ω and the photoelectric threshold λ_0 each have more than one value for sodium and potassium. The thermionic emission i from a substance with multiple thresholds should be given as a function of the temperature by the expression $i = A_1T^2e^{-\omega_1/T} + A_2T^2e^{-\omega_2/T} + \ldots$ with one term for each threshold. Such an expression with two terms represents typical experimental data for potassium. There are similar but less complete data for sodium. The fact that the photoelectric currents saturate readily, but the thermionic currents do not, indicates that the separate thresholds are localised in patches on the surface. The photoelectric threshold for normal potassium is close to 7000 Å.U., which agrees with the known wave-lengths of maximum] activity $\lambda_{\max.}$ and the equation $\lambda_0 = 3/2\,\lambda_{\max.}$ Uncertain traces of a thermionic threshold agreeing with this have been found at about 200° C. in one experiment, but the thermionic thresholds usually effective at this and lower temperatures are of a much lower magnitude, even under the best vacuum conditions. Satisfactory investigation at appreciably higher temperatures is precluded by various complications which develop. A common thermionic threshold effective at about 200° C. corresponds to $\lambda_0 =$ about 10,000 Å.U. A photoelectric emission with this infra-red threshold has been got by exposing potassium to a luminous discharge in hydrogen or water-vapour. It is suggested that this is due to the growth of small patches normally present. No evidence is found of photoelectric activity farther out in the infra-red, although there is a thermionic threshold which corresponds to $\lambda_0 = 30{,}000$ Å.U. All the various pairs of values of A and ω come near to satisfying a linear relation between ω and log A. The glow-discharge not only brings out undeveloped thresholds, but it also augments the normal emission. A tentative classification of the effects is suggested and some unsettled alternatives are partly indicated. [See Abstract 927 (1924).] A. E. G.

1721. *Richardson-Effect.* **D. Reichinstein.** (Zeits. Elektrochem. 31. pp. 124–135, March, 1925.)—A general discussion is given of the Richardson-effect and the electron phenomena in a two-electrode tube with high vacuum. A theoretical treatment then leads to the conclusion that certain effects are to be expected in such tubes. These effects may possibly be tested experimentally. A. W.

1722. *A General Method of Determining the Constants of Oscillating Circuits.* **F. Müller.** (Archiv f. Elektrot. 14. pp. 397–405, Feb. 20, 1925.)—This is a mathematical paper in which is given a general method of determining the oscillation constants, number of oscillations, damping of radiation, current and tension distribution. A. E. G.

1723. *Propagation of Radio Waves over the Earth.* **H. W. Nichols** and **J. C. Schelleng.** (Nature, 115. p. 334, March 7, 1925.)—The authors here outline a new transmission theory which is stated to account quantitatively for many facts hitherto unexplained. The theory stated to be now developed and shortly to be published takes into account both the earth's magnetic field and the atmospheric distribution of ionised particles, which together produce marked selective effects at wave-lengths between 100 and 200 m., and these effects differ for different directions of transmission and for different planes of polarisation of the wave. When the electric force of the wave is parallel to the earth's magnetic field, the only effect is due to variation in ionic density above the earth. In practice this case can be realised only over very limited areas of the earth's surface. For transmission in any other direction or for any other direction in the electric field four effects are in general produced: (1) The plane of polarisation of the wave is rotated by an amount depending on the density of free electrons, the magnetic field, and the frequency. The rotation reverses at a critical frequency, which, for a field of 0·5 gausses, is 1400 kilocycles, corresponding to a wave-length of 214 m. (2) A double refraction in the medium, giving rise to two waves differing in velocity and in polarisation. (3) A bending of the rays due to variation in ionic concentration, as in Larmor's case, but, due to the magnetic field, this bending

also, in most cases, reverses at the critical frequency. so that if long waves bend down in a certain region, short waves will be deflected upwards in the same region. (4) A bending of the rays arising from variations in the magnetic field. This bending also reverses at the critical frequency.
G. W. DE T.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1724. *Kinetic Theory of Metallic Conduction and the Scattering of Electrons by Atoms.* **E. L. Davies** and **G. H. Livens.** (Cambridge Phil. Soc., Proc. 22. pp. 555–561, March, 1925.)—The general expressions due to Lorentz for the electrical (κ) and thermal (γ) conductivities of a metal due to the diffusion of electrons through a lattice of fixed force centres are :—

$$\kappa = \frac{8Ne^2q^{5/2}}{3m\sqrt{\pi}}\int_0^\infty \tau_m u^4 e^{-qu^2}du$$

and

$$\gamma = \frac{2Nmq^{5/2}}{3\sqrt{\pi}}\frac{dq}{d\theta}\int_0^\infty \tau_m u^6 e^{-qu^2}du$$

where q is given by $3/2u_0^2$. The τ_m is a function representing the action of a force centre on an electron passing near it. Work on the absorption of β-rays suggests a form μu^n where n is > 5, but it appears that this cannot be applicable to the small velocities of encounter in a metal. With the form $\mu u^{\frac{5-n}{n-1}}$, Lorentz makes $n = \infty$. Keeping the general form, the expressions can be reduced to

$$\kappa = \frac{8}{3\sqrt{\pi}}\frac{Ne^2\mu}{mq^{\frac{n}{2}}}\Gamma\left(\frac{n+5}{2}\right)$$

$$\gamma = \frac{2}{3\sqrt{\pi}}\frac{Nm\mu}{q^{\frac{n+2}{2}}}\frac{d}{d\theta}\left(\frac{1}{q}\right)\Gamma\left(\frac{n+7}{2}\right)$$

and to make these fit the experimental facts as well as possible, it appears that $n + 2 = 0$ or $\tau_m = \mu u^{-2}$. The numerical results given by this assumption are of the right order, and several causes can be assigned for the observed error. It is also pointed out that the phenomena observed at very low temperatures can be very nearly explained if it be assumed that the total energy of an electron at a temperature θ is given by an expression of the form

$$C\int_0^x \frac{x^3dx}{e^{\frac{x}{R\theta}}-1} - T_0$$

where T_0 is a small quantity independent of the temperature. It is concluded that a purely kinetic theory is quite capable of explaining the phenomena of conductivity in metals.
A. Wh.

1725. *Electric Equilibrium at Surfaces of Metals in Contact.* **E. H. Hall.** (Nat. Acad. Sci., Proc. 11. pp. 111–116, Feb., 1925.)—The Volta-effect is due to a difference of surface charge caused by the contest between the ions of the two metals for the possession of electrons. The parts played by associated and free electrons are discussed.
G. A. S.

1726. *Thermo-electric Condition and Structure of Pure Iron.* **A. Goetz.** (Phys. Zeits. 26. pp. 260–264, March 1, 1925. Paper read before the Deut. Phys. Gesell, Göttingen, Feb., 1925.)—Develops a theory which explains the observed phenomena described in a previous paper. [See Abstract 659 (1925).] G. A. S.

1727. *On Contact Resistance.* **R. Holm.** (Zeits. techn. Physik, 6. 5. pp. 166–172, 1925.)—This paper continues a previous investigation [see Abstract 365 (1923)], in which a contact theory is advanced on the essential assumption that only very minute parts (πa^2 surfaces) of an Hertzian contact surface experience metallic contact. By resistance measurements for currents applied during short periods, it is found how quickly the vicinity of the πa^2 surfaces assumes the temperature elevation due to the current. This period appears to be essentially less than 10^{-5} sec., so that a becomes less than $3 \cdot 10^{-5}$cm., thereby affording strong support for the theory. The paper is replete with experimental details, data, etc. H. H. Ho.

1728. *The Long Wave-length Limit of the Photoelectric Effect in Mercury.* **Sophie Taubes.** (Ann. d. Physik, 76. 6. pp. 629–672, April, 1925.)—Mercury particles with a radius of about 10^{-4} cm. were made to "float" in a Millikan condenser, and illuminated with monochromatic ultra-violet light, $\lambda_1 = 2321$, $\lambda_2 = 2573$ and $\lambda_3 = 2796$ Å., until the charge became constant. Using Einstein's equation and the radius of the particle calculated from the Stokes-Cunningham law, the long wave-length limit of the photo-effect was then determined, taking into account the charge induced on the particle in the condenser field. The effect of the surrounding gas due to loss of energy by the electrons, caused by inelastic collisions with gas molecules, was eliminated by making the measurements in very pure dry argon at a pressure of about 10 cm. Hg. That no inelastic collisions took place was shown by the fact that the final charge was independent of the pressure. From measurements on ninety particles the value of the limiting wave-length was found to be **3043 ± 20 Å.** The theory of the method is fully discussed in the original paper. H. N. A.

1729. *Selective Photoelectric Effect in Metallic Layers.* **F. Gross.** (Zeits. f. Physik, 31. 9. pp. 637–646, 1925.)—A copper layer produced by vaporisation of a "Cumodraht" (copper molybdenum wire) *in vacuo* shows a smaller selective photoelectric effect for $\lambda = 254\ \mu\mu$ than a layer obtained by kathode sputtering in hydrogen. Copper vaporised *in vacuo* from a magnesia crucible gives no selective effect for this wave-length, and the same is true of bismuth layers, whether produced by sputtering in hydrogen or evaporation *in vacuo*. Different silver layers give no conclusive evidence. Copper layers have a constant sensitivity; in the case of silver and bismuth there is a falling off with time. The selective effect in the case of copper is considered to be bound up with the presence of occluded gas in the layer. It is uncertain whether some layers possess no selective effect whatever or whether this effect is simply displaced towards shorter wave-lengths. G. A. S.

1730. *Dielectric Constants of Solutions of Electrolytes.* **P. Walden, H. Ulich** and **O. Werner.** (Zeits. Phys. Chem. 115. pp. 177–202, March 28, 1925.)—A resonance method is employed for the determination of dielectric constants which employs radio-frequencies in order to minimise the effect of power absorption. The solution to be measured forms the dielectric medium of a condenser which forms part of the primary of an oscillating circuit. Two coupled circuits are employed, each of which contains an inductance and condenser. Oscillations are generated in the primary circuit, and if the second is adjusted to the same frequency, oscillations of maximum amplitude are obtained. The amplitude is indicated by a vacuum thermo-element connected to a galvanometer and coupled inductively with the secondary circuit. The oscillations are produced in the primary circuit by a method of Holborn, using an electron tube. Wave-lengths as low as 3–6 m. are obtained. The conductivity of the dielectric leads to an absorption of power, which lowers the electrical potential or amplitude of the oscillations. A measurement of the conductivity or power absorption is made by replacing the condenser containing the measuring liquid by an air condenser which is connected in parallel with a non-reactive resistance. The resistance is adjusted to give the same maximum amplitude as that given when the condenser and resistance are replaced by the liquid under measurement, and thus gives directly the value of the resistance of the liquid. A formula is derived to show, in terms of the capacity and inductance, the increase of total capacity of the condenser through the conductivity of the dielectric. [See Abstracts 1211 (1923), 2584, 2587 (1924).] J. N. P.

1731. *Determination of Resistance in Terms of Mutual Inductance.* **A. Campbell.** (Roy. Soc., Proc. 107. pp. 310–312, Feb. 2, 1925.)—See also Abstract 1486 (1925).

1732. *Comparison of Capacities and High Resistances by the Neon Lamp.* **J. Taylor, W. Clarkson** and **W. Stephenson.** (Journ. Sci. Instruments, 2. pp. 154–158, Feb., 1925.)—The method of comparison of capacities and high resistances [see Abstracts 1579 and 2569 (1924)] is considered in the light of recent work on the constants of neon lamps, and the effect of external ionising agents on the period of flashing is discussed. An alternative position of the capacity across the circuit resistance and its application to the capacity and resistance comparisons are considered. A. A. D.

1733. *Some Applications of Three and Four-electrode Valves to Photoelectric Cells.* **G. Ferrié.** (Onde Élec. 4. pp. 97–110, March, 1925.)—Describes the potassium cell of Rougier, in which the photoelectric surface consists of potassium hydride, the emission being augmented by the introduction of a small quantity of argon into the tube. Very intense illumination produces a photoelectric current of only 1 microamp., and a method of amplification is shown by allowing the current to charge the condenser formed by the grid and anode of a three-electrode valve. To diminish ionisation by collision within the valve a four-electrode valve is recommended, using a plate voltage of 20 volts or less. Methods of measuring the photoelectric current are given, together with numerous scientific applications of the cell. By attaching a small mirror to the rod of a pendulum, a graphic record of its motion can be obtained and a computation of the gravitational force made: it can also be employed in the measurement of the frequency of a maintained tuning-fork and in stellar photometry, the stars Capella and Bouvier, for example, producing plate current variations of 3·5 and 1 microamp. respectively when two-stage amplification—one four-electrode and one three-electrode valve—is employed. E. T. A. R.

1734. *Piezo-electric Standards of High Frequency.* **W. G. Cady.** (Optical Soc. America, J. and Rev. Sci. Inst. 10. pp. 475–489, April, 1925.)—The paper describes the construction and use of frequency standards consisting of properly mounted plates or rods of quartz, or of steel rods excited by quartz plates, vibrating in one of their normal modes, making use of the piezo-electric reactions of the quartz upon the resonant high-frequency circuit, which maintains the oscillations. The transverse piezo-electric effect, in which vibrations take place in a direction perpendicular to the electric field, is chiefly used in the resonators. Owing to the unrivalled mechanical properties of quartz these resonators possess all the qualities of constancy, low decrement, simplicity, etc., which should characterise a standard. Any given resonator may be excited to resonant vibrations in its fundamental or any one of several overtones, thus serving for several frequencies. In construction the resonators for the highest frequencies, up to 3,000,000 cycles per sec., consist of a quartz plate in the form of a narrow rod loosely supported in an insulating block between brass exciting plates. For frequencies below 50 kilocycles per sec. freely supported steel rods are used excited to longitudinal vibration by a pair of quartz plates cemented to the rods at the centre; resonators as low as 3000 cycles per sec. are made in this way. Over the whole frequency range a valve generator can be synchronised with the resonator within 0·01 %. The circuits used are described and the electric reactions of the resonator therein are explained. The applications of piezo-electric resonators for frequency stabilisation or for the generation of continuous oscillations are briefly treated; in these applications the longitudinal effect is utilised. B. H.

1735. *Design of Electrical Contacts for Resistance Boxes, etc.* **G. Barlow** and **H. B. Keene.** (Journ. Sci. Instruments, 2. pp. 151–153, Feb., 1925.)—This note describes a new design of electrical contact which enables all contact surfaces to be cleaned with ease. The shorting resistance of the contact is low and of constant magnitude. A. A. D.

ALTERNATING CURRENTS AND MAGNETISM.

1736. *The Determination of the Frequency of an Alternating Current by the Vibrations of Rods.* **G. F. C. Searle.** (Cambridge Phil. Soc., Proc. 22. pp. 539–547, March, 1925.)—If n be the frequency of transverse vibrations of a uniform rod of circular section, clamped at one end, $n = m^2 \cdot \frac{r}{4\pi l^2}\sqrt{\frac{E}{\rho}}$ where r is the radius of the cross section, l the free length of the rod, E is Young's modulus, and ρ the density. The number m is a root of the equation: $\cos m \cosh m = -1$. The successive values of m correspond to vibrations with no node, one node, two nodes. . . . The frequency, for a given number of nodes, is inversely proportional to l^2, hence if the length l_0 for a known frequency n_0 be determined, the frequency corresponding to any other observed length l is $n = n_0 l_0^2/l^2$. The rod may therefore be calibrated by a tuning-fork. To determine the frequency of an alternating current a thin silver steel rod 0·25 cm. diam. clamped at one end may be used. A small electromagnet is placed near the rod and energised by the current whose frequency is to be found. The rod also passes through a solenoid in which, if desired, a direct current may be passed so as to magnetise the rod. When this latter magnetising coil is idle, the alternating force set up between the electromagnet and the rod will have a frequency 2N, where N is the frequency of the currents; when direct current flows through the magnetising coil and the rod is suitably adjusted, it will respond to the frequency N. For details of the actual method of determining the frequency, the original article should be consulted. A. E. C.

1737. *Comparison of Mutual Inductances at Telephonic Frequencies.* **L. Hartshorn.** (Journ. Sci. Instruments, 2. pp. 145–151, Feb., 1925.)—A new method for the comparison of unequal mutual inductances at telephonic frequencies is described. It is considered chiefly as a means of calibrating high-range mutual inductance standards. Its advantages are: (1) The instrument can be tested with any desired common point; (2) the "impurity" or "phase defect" of the instrument is determined at the same time as the mutual inductance. Results of a test on a 100-millihenry inductometer are given in order to show the importance of the common point on mutual inductances used with currents of telephonic frequency. A. A. D.

1738. *Tables for the Calculation of the Mutual Inductance of Circuits with Circular Symmetry about a Common Axis.* **F. W. Grover.** (Bureau of Standards, Sci. Papers No. 498. pp. 1–18, 1925.)—In the calculation of the inductance of circuits which have circular symmetry about an axis, the case of two circular coaxial filaments is of fundamental importance. By integrating of formulæ for this simple case, formulæ for the inductance of coils of finite cross-section may be derived, and even in cases where it is impossible to perform the integration, numerical values of the inductance may be obtained from the simple case by mechanical quadrature. In the present paper tables are given which permit of the value of the mutual inductance being readily computed to an accuracy of 1 part in 10,000, and examples are given explaining clearly the method of using the tables. A. E. C.

1739. *Terrestrial Magnetism.* **D. L. Hazard.** (Washington Acad. Sci., J. 15. pp. 111–125, March 19, 1925.)—This address deals with the history of terrestrial magnetism in the twentieth century. It outlines the development of international cooperation, which has led to the founding of observatories all over the world. It also deals with the various views advanced by different workers to account for the magnetism of the earth. A. A. D.

1740. *After-disturbances, Activity and Diurnal Variation of the Horizontal Component of the Earth's Magnetisation.* **W. van Bemmelen.** (Zeits. techn. Physik, 42. pp. 143–147, April, 1925.)—The author summarises earlier work by himself and Bartels [Abstract 1292 (1924)], and from an examination of results from Batavia sets out in tabular form for magnetically different days (1) the mean character, k; (2) the variation of the horizontal component $u(X)$; and (3) the difference between calculated and observed values. He thus obtains the expression :—

$$u(X) = 4 \cdot 5 + 3 \cdot 1 (k - 1)^2.$$

The character of the storm and the diurnal variation of the horizontal intensity are criteria of magnetic storm phenomena, and both are necessary for its complete definition. The diurnal variation of the horizontal intensity is an expression of the after-disturbance phenomena. To explain these phenomena the author imagines a circular current round the earth, fed continually by electrons from the sun and also losing them. The axis of this current is approximately the earth's magnetic axis. The position of the sun brings about twelve hourly, daily, six monthly, and yearly oscillations in the magnitude of the current, the two latter being in agreement with the diurnal variation of the earth's magnetic field. R. S. R.

1741. *The Physical Nature of the Earth's Magnetic Field.* **G. Angenheister.** (Phys. Zeits. 26. pp. 305–320, April 21, 1925.)—This is a report originally presented to a conference in 1924 dealing with most of the factors which are supposed to be connected with the magnetic field of the earth. The following summary indicates the scope of the paper. (1) An account of the distribution of observatories over the earth's surface and the observations made. (2) The earth's inner field—the symmetrical part due to rotation. Comparison of the fields of earth and sun. The transverse magnetisation of the earth. The relation between the inner field and the secular variation. (3) The outer field and its relation to the secular variation. (4) The periodic variation and its relation to both the inner and outer fields. (5) Magnetic storms. Relation between storms and the polar light. Influence of the sun. (6) The non-potential part of the earth's field. A. A. D.

1742. *Records of the Survey of India.* (Survey of India, Records, 18. [132 pp.], 1921–1922.)—Includes magnetic survey, etc.

1743. *The Various Magnetic States of an Ion.* **G. Foëx.** (Comptes Rendus, 180. pp. 919–921, March 23, 1925.)—The facts cited in the paper show that two specimens of a salt, perfectly definite from a chemical standpoint and placed under identical conditions may show very different magnetic properties corresponding to distinct structures of the paramagnetic ions they contain. (1) In concentrated solutions of ferrous ammonium sulphate (Bohr's salt) the ion Fe·· may have either of the four conditions stated below: (*a*) 26 magnetons with a positive molecular field; (*b*) 26·5 magnetons and a molecular field approximately zero; (*c*) 27 and 27·5 magnetons with a negative molecular field. The cryomagnetic anomalies are due to the simultaneous existence of an anisotropic molecular field and crystalline actions which tend to maintain the atoms' orientation with respect to the lattice. The existence of the molecular field and that of the anomaly in the salt of 26 magnetons distinguish it from the 27·5 magneton variety in a very complete manner. (2) The anhydrous sulphate of cobalt has at least two magnetic varieties, 25 magnetons with a negative molecular field and 24 magnetons with a small positive field. The various magnetic conditions differ in the value of the atomic moment and the value and sign of the constant *n* of the molecular field. The mechanism which gives rise to the molecular field appears to be related to that which produces the atomic moment. W. V. M.

1744. *Magnetic Properties of Iron Crystals.* **W. L. Webster.** (Roy. Soc., Proc. 107. pp. 496–509, March 2, 1925.)—The magnetic properties of iron crystals can be explained on the Weiss theory of molecular fields. The magnitude of the molecular field in the case of two crystals of iron was found to be 620 and 479 gauss respectively. The magnitude of the component of the molecular field along any axis varies as $\cos^4 \psi$, where ψ is the angle between the direction of magnetisation and the axis. The molecular field is a stable property of the crystal and is probably not due to magnetic forces; it is considerably affected by the presence of impurities in the crystal. J. S. G. T.

1745. *Anhysteretic Magnetostrictive Effects in Iron, Nickel and Cobalt.* **P. McCorkle.** (Phys. Rev. 25. pp. 541–549, April, 1925.)—(1) *Effect of tension upon the intensity of magnetisation.*—The rod about 23 cm. long is suspended along the axis of a vertical solenoid. A suitable load is hung from the rod. The field is applied using one set of turns on the solenoid. Through another set of turns an alternating current is increased to a maximum and then brought to zero. The magnetometer is then read. By these means hysteresis is almost eliminated. In the case of iron, with a weak field (0·85 gauss), the first effect of tension in a freshly annealed specimen is an increase of intensity of magnetisation to a maximum, but successive cycles of loading cause this initial increase to disappear. For a field of 1·55 gauss the effect was a decrease from the start being considerably greater than when hysteresis was not eliminated. In the cases of nickel and cobalt the effect is a steady decrease of intensity. The elimination of hysteresis greatly increased the effect in nickel but not in cobalt. (2) *Effect of a longitudinal field on the length of the specimen under tension.*—A load of $7 \cdot 6 \times 10^7$ dynes/cm. was applied to the specimen and the variation of length under anhysteristic conditions measured for different fields. In the case of iron there was an increase in length; in the case of nickel there was a decrease in length, and in the case of cobalt the effect was too small to measure. The thermodynamic relation between the two effects $(\partial I/\partial F)_H = (\partial L/\partial H)_F$, where F is the tension, is not satisfied by the results obtained. This is not surprising in view of the discrepancies between the observations upon different samples of the same material. [See also Abstract 660 (1924).] A. A. D.

1746. *Effect of a Superposed Alternating Field on Apparent Magnetic Permeability and Hysteresis Loss.* **T. Spooner.** (Phys. Rev. 25. pp. 527–540, April, 1925.)—It is often assumed that when an alternating magnetising field is superposed on a constant magnetising field the permeability of the magnetic material is increased and the hysteresis loss decreased owing to the shaking-up action of the alternating magnetic field on the magnetic particles. It is shown that these effects are only apparent and that the true permeability and hysteresis remain approximately the same as under constant field conditions. What are actually measured are the midpoints of displaced minor hysteresis loops. From the known laws of variation of these minor loops the apparent magnetisation curves and hysteresis loops under a superposed alternating field can be calculated. The method of doing this is illustrated. Under these assumptions a superposed alternating field actually increases the hysteresis loss instead of suppressing it. As has often been assumed, the resulting hysteresis includes losses due to displaced minor loops besides those due to an increased major loop. These conclusions are supported by magnetisation curves obtained with 1 % Si steel punchings which are shown to agree with the calculated curves. Some consideration is given to the case when the fields are at right angles, but at present it is not susceptible to quantitative calculations. A. A. D.

1747. *Magnetic Properties of 50 % Iron-Nickel Alloy.* **T. D. Yensen.** (Frank. Inst., J. 199. pp. 333–342, March, 1925.)—The series of iron-nickel alloys provides metals with properties which vary over wide ranges, *e.g.* from weak to strong, from low to high thermal expansion, from small to large electrical resistance, and from nearly non-magnetic alloys to those with a higher permeability than pure iron. Of the various alloys with a third constituent, only Mn and Ti make alloys which are forgeable, and of these Mn produces by far the best magnetic properties. A comparison is made of the 50 % iron-nickel alloy with that containing 78 % Ni, and with iron and 4 % silicon-iron. Except for initial permeability, the 50 % alloy is equal to or better than the 78 % alloy. It has 50 % higher saturation value and over double the electrical resistance, this property being valuable in connection with alternating currents. [See also Abstract 2596 (1924).] G. E. A.

1748. *The Photomagnetic Properties of the Silver Halides.* **A. Garrison.** (Am. Chem. Soc., J. 47. pp. 622–626, March, 1925.)—The investigation was a qualitative one; silver chloride, bromide and iodide were fused and cast into small needles, which could be suspended by quartz fibres between the poles of an electromagnet, the axis of the needle making an angle of 45° with the direction of the lines of force before the current was switched on. Silver chloride, which is diamagnetic, is deflected away from the lines of force when the current is switched on, the amount of deflection diminishing when it is illuminated. AgBr and AgI are paramagnetic, and the needles are deflected towards the direction of the field, this deflection being increased when the needles are illuminated. The magnetic permeability of all three substances was thus increased by visible radiation. A rise of temperature by the absorption of dark heat rays also increases the permeability of each salt, but the changes are slow, while the effect of light is instantaneous. This behaviour is discussed in the light of Langevin's theory of magnetism, and it is shown that a change in permeability would naturally accompany an increase in electrical polarity, such as is suggested by the fact that the absorption of light causes the halides to be more soluble in water, and better conductors of electricity. H. N. A.

RADIOGRAPHY AND ELECTRO-PHYSIOLOGY.

1749. *The Limitations of the Antagonistic Action of Spectra and the Application of Long Wave-length Radiations in the Treatment of Radiodermites and Neoplasms.* **J. Risler** and **P. Mondain.** (Comptes Rendus, 180. pp. 964–966, March 23, 1925.)—It has been shown that an antagonistic action occurs between infra-red radiation and X-radiation for both photographic and physiological actions. The present authors show that this action is not limited to the infra-red, but occurs with visible light. Experiments were carried out upon guinea-pigs with a soft X-radiation and an arc giving visible light of the compounds (salts of strontium and lithium) with which the carbons were impregnated. One batch of animals was submitted to the X-radiation only, and showed dermites, blood changes, loss of weight, etc. The other batch was submitted to both radiations, and did not show these changes, an increase in weight occurring. Further experiments upon animals are then described in which neoplasms were submitted (1) to light radiation from an arc, (2) to fluorescent or phosphorescent light. The occurrence of a photoelectric action was shown and the improvement of the pathological condition resulted. The authors have further verified the truth of Stokes' laws for soft X-rays. B. J. L.

1750. *Some Developments in Deep Radio-therapy.* **N. S. Finzi.** (Brit. J. of Radiology, 21. pp. 67–74; Disc., 74–80, April, 1925.)—The methods of irradiation in deep therapy may be summarised as (1) multiple short-distance fields; (2) a few long-distance fields; (3) one or two long-distance fields, with a number of accessory short-distance fields.

The present paper is a general one, in which are discussed apparatus, the erythema dose, methods of dividing dosage, and the irradiation of neoplasms in certain anatomical positions. The paper concludes with probable future developments, and is followed by a discussion in which most conflictory opinions are expressed. B. J. L.

1751. *Photoelectric Effect produced by Ultra-violet Rays in Man.* **J. Saidman.** (Comptes Rendus, 180. pp. 693–694, March 2, 1925.)—Biological effects due to ultra-violet light are probably photoelectric in origin, variations in electrification having been observed in plants exposed to ultra-violet radiation. Experiments were conducted with a man, who was negatively charged whilst insulated from earth and found to lose the negative charge when irradiated by ultra-violet light. Details of such experiments are given, and the decrease of negative charge was found to occur for a short period after cessation of the radiation. In man under normal conditions such a discharge of negative electricity occurs naturally in sunlight, and whilst the effect is practically unvaried in white light from a lamp the discharge is rapidly increased in ultra-violet light. The subject of therapeutic action of ultra-violet radiations in terms of such effects is discussed, and further experiments are to be carried out. B. J. L.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1752. *New Determination of the Constant* N *of Avogadro.* **L. M. Alexander.** (Phil. Mag. 49. pp. 663–664, April, 1925.)—Numerical errors in du Noüy's paper on this subject [Abstract 431 (1925)] are pointed out, and it is shown that the three "control" calculations given are fallacious. T. H. P.

1753. *Adsorption in the Vicinity of the Critical Temperature.* **W. A. Patrick, W. C. Preston** and **A. E. Owens.** (J. Phys. Chem. 29. pp. 421–434, April, 1925.)—Continuing previous work in which the adsorption of gases by silica gel was studied, and it was shown that the empiric relationship $V = K(P\sigma/P_0)^{1/n}$, where V is the volume of liquefied gas adsorbed per gramme of gel, P the equilibrium pressure, P_0 the ordinary saturation pressure at the temperature, σ the surface tension of the liquefied gas, K and $1/n$ constants depending entirely on the structure of the gel [see Abstracts 1224 and 1225 (1925)]. The adsorption of carbon dioxide and nitrous oxide by silica gel was studied. Silica gel was prepared by precipitating sodium silicate with hydrochloric acid and thoroughly washing the precipitated gel. After drying and washing, it was again dried at 400° C., ground and sieved to pass a 10-mesh sieve, and again heated. It then contained 3·64 % moisture. A second lot similarly prepared, but heated to 700°–750° C., contained 1·28 % moisture. The adsorption of carbon dioxide and nitrous oxide by these silica gels was accurately measured, at temperatures of 0°, 20°, 30° and 40° C. at pressures below an atmosphere. It was found that K was not constant at all temperatures, and it is suggested that the increase in surface tension of the liquid in the capillaries at temperatures near the critical temperatures is the cause of the discrepancy. A method for correcting the surface tension is given, and when the corrected values are used, the results are in accord with the theory, and K and $1/n$ are dependent only upon the structure of the gel. The capillary theory of adsorption has been extended to temperatures above the critical temperature, and evidence is brought forth to indicate that the critical temperature is raised in the pores of the adsorbent. F. J. B.

1754. *Studies in Adsorption. Part X.* **S. Ghosh** and **N. R. Dhar.** (J. Phys. Chem. 29. pp. 435–461, April, 1925.)—It was shown in previous papers how the concentration of a sol influences its coagulation by electrolytes. Continuing the work, negatively charged stannic hydroxide was obtained by the addition of $SnCl_4$ to a dilute solution of caustic soda and subsequent dialysis. The coagulation of the sol by different electrolytes was shown to follow the Schulze-Hardy law with the exception of thorium nitrate. Sols are divided into two classes, normal and abnormal. $Cr(OH)_3$, $Fe(OH)_3$, $Sn(OH)_4$, Gold (Donau) and Sulphur (Weimann) are classified as normal; As_2S_3, Sb_2S_3, Mastic and Sulphur (Odèn), as abnormal. The acclimatisation of sols was studied—that is, the amount of electrolyte necessary for complete coagulation when the addition is slow. The colloid is said to become acclimatised to the presence of the electrolyte. It was found that sols, especially Sb_2S_3 and As_2S_3, "aged"—that is, a smaller amount of electrolyte was required to complete precipitation when the sol was kept for a time. Thus 5 c.c. of a sol containing 2 grs. of potassium antimony tartrate when freshly prepared required 0·85 c.c. N/25 NaCl for complete precipitation, but after thirty-three days it required only 0·70 c.c. NaCl solution. [See Abstract 1940 (1924).] F. J. B.

1755. *Adsorption from the Gas Phase at a Liquid-gas Interface. Part III.* **T. Iredale.** (Phil. Mag. 49. pp. 603–627, March, 1925.)—In previous work [see Abstract 2847 (1924)] certain difficulties were experienced in measuring the surface tension of mercury in a vacuum by the drop method. These were due to the rapid accumulation of impurities on the surface. These impurities are probably derived in part from the glass surfaces with which the mercury comes in contact. Such contamination is shown to be irreversible, and cannot be removed at ordinary temperatures, even in the highest vacua. Extraordinary precautions in cleanliness are taken by the author, and the method of sessile drops is employed to measure the surface tension σ. This involves measurement of the distance (h) from the top of the drop to its maximum diameter. In the case of large drops $\sigma = h^2\rho g/2$, where ρ is the density. It is shown that when the mercury surface is exposed to vapours at different pressures, these vapours are adsorbed on the Hg surface to give films one molecule in thickness. The adsorption of the vapours of benzene, ethyl alcohol, and some other organic substances is found to be largely reversible, except in the case of substances (*e.g.* methyl iodide) which are known to form definite compounds with mercury. The investigation of the adsorption of vapours on liquid surfaces is considered to open up a new and promising field for the study of adsorption films and molecular structure. Results of the direct measurement of the adsorption are promised. T. B.

1756. *Thermodynamic Consequences from the Equation of State for Adsorbed Substances.* **M. Volmer.** (Zeits. phys. Chem. 115. pp. 253–260, March 28, 1925.)—Thermodynamic consideration of an isothermal adsorption cycle leads to the equation of state, $\pi(\Omega - \beta) = RT$, which, within certain limits, is in agreement with experimental results. Further, within these limits, the heat of dilution of adsorbed substances is zero, or, what amounts to the same thing, the heat of adsorption is independent of the quantity of substance already adsorbed. This conclusion is in apparent disagreement with the results of experimental measurements of heats of adsorption by charcoal, meerschaum, etc. Such microcrystalline substances are, however, not individual adsorbents, but must be treated as a mixture of a number of substances with a single surface composed of crystallographically different faces. In the successive adsorption of quantities of gas, the heat of adsorption at first corresponds with the strongly adsorbing surfaces, and as these become increasingly saturated, adsorption at the surfaces with lower heats of adsorption predominates. Such powders cannot, therefore, yield results of value for determining the laws of adsorption. T. H. P.

1757. *The Cryoscopic Method for Adsorption.* **H. L. Richardson and P. W. Robertson.** (Chem. Soc., J. 127. pp. 553–556, March, 1925.)—A determination is made of the adsorption of different liquids by purified animal charcoal by a cryoscopic method by measuring with a Beckmann apparatus the depression of freezing-point of a given solute in a given solvent both alone and in presence of the charcoal. The adsorption ratio of the solute in the charcoal and the solvent, or the ratio C_2/C_1, is determined in each case for different concentrations. Curves plotted for log C_2 against log C_1 give straight lines for any given solute and solvent in accordance with the relation $C_2 = KC^{1/n}$. The magnitude of n for different compounds in water as solvent lies between 1·45 and 4·8. Aromatic compounds are more readily adsorbed than aliphatic, and generally molecular complexity tends to increase the adsorbability of a compound. Measurements are also conducted with phenol as solvent and employing as solutes methyl alcohol, stearic acid, methyl succinate, water and benzene. In every instance the adsorption is nil, even for a compound of some complexity such as stearic acid. This negative result is in agreement with the generally recognised fact that compounds which are readily adsorbed as solvents prevent adsorption. J. N. P.

1758. *Mechanism of Adsorption of Ions.* **R. Audubert** and **Marguerite Quintin.** (Comptes Rendus, 180. pp. 513–515, Feb. 16, 1925.)—It has been shown previously [Abstract 1488 (1923)] that Freundlich's empirical formula is applicable to the fixation of different ions by particles of mastic and gamboge and to that of silver ions by gelatin. In all cases, the relation derived from the experimental data is of the form $x = BC^p$, where x is the quantity fixed by unit surface, C the equilibrium concentration, and B a coefficient dependent on the valency of the ion and, to a less degree, on the nature of the surface. The fact that the exponent p has the value 0·5 for all the adsorbents and adsorbed bodies appears to indicate that the actuating factors of the phenomenon are independent of the wall, and it may be supposed that the adsorption equilibrium of ions is conditioned essentially by electrostatic and osmotic forces. Various consequences of this theory are worked out, and these are found to be confirmed by further measurements of adsorption of ions by suspensions of mastic and gamboge and by gelatin. For the first two adsorbents the variation in charge was determined by microscopic measurement of the mobility, due correction being made for the displacement of the liquid; with gelatin the method of concentration cells was employed. In the former case, if U_0 represents the mobility before addition of electrolyte and U that corresponding with the concentration C of the electrolyte, $U_0 - U = s_0 - s = \sigma = BC^{0 \cdot 5}$. If B_1, B_2, B_3 are the values of B for uni-, bi-, and ter-valent ions, approximately $B_2 = B_1^2$ and $B_3 = B_1^3$, which is in accord with the theory. T. H. P.

1759. *The Surface Concentration of Gelatine at a Liquid-gas Interface as indicated by the Change in Surface Tension.* **J. M. Johlin.** (J. Phys. Chem. 29. pp. 271–284, March, 1925.)—The surface tension of ash-free isoelectric gelatine measured at 40° C. at the interface between air and solutions of varying concentration varies for a period with the age of the interface according to the expression $\sigma = \frac{a}{t^n}$, where σ is surface tension, t is time, a and n are constants. Experiments with the drop-weight and capillary-rise methods show that this formula does not hold under all conditions, and no absolute value for the surface tension appears to be arrived at. The change of surface tension with hydrogen ion concentration is also studied, and there is evidence of a gradual adsorption of gelatine at the interface, complicated by the presence of hydrolysis products in certain cases. Other colloids—such as proteins, silica gel, etc.—show similar behaviour. B. W. C.

1760. *Stability of Suspensions. I. Rate of Sedimentation of Kaolin Suspensions by Salts at Varying Hydrogen-ion Concentrations.* **W. O. Kermack** and **W. T. H. Williamson.** (Roy. Soc. Edinburgh, Proc. 45. 1. pp. 59–70, 1924–1925.)—The rates of sedimentation of a kaolin suspension in presence of varying concentrations of different salts containing uni-, bi-, and ter-valent ions have been compared at various p_H values. Abnormal results are obtained with certain of these salts. Sodium chloride exhibits a specific action, increasing the rate of sedimentation in alkaline, but inhibiting it in acid, solution. In solutions containing more than 0·06 % of monocalcium phosphate the sedimentation is abnormal in alkaline solution, being far more complete than in acid solution of the corresponding concentrations. In acid solution the tervalent aluminium, ferric, and lanthanum ions have little effect, but a zone of very marked flocculation occurs at p_H 7–8 ; this zone separates a region within which the unsedimented particles are negatively charged from a region within which they are positively charged. T. H. P.

1761. *A Quantitative Study of the Protection attained in a Colloidal Solution by the Introduction of an Electrolyte in Quantity insufficient to Produce Coagulation.* **A. Boutaric** and **G. Perreau.** (Comptes Rendus, 180. pp. 1337–1340, May 4, 1925.)—This paper is a quantitative study of a previous qualitative observation [see Abstract 2869 (1924)] on the protective effects of very small quantities of electrolytes. Curves showing rates of coagulation are included which are found to be asymptotic to the time axis. H. H. Ho.

1762. *Spectrographic Study of the Formation of Complex Compounds in Solution and of their Stability.* **P. Job.** (Comptes Rendus, 180. pp. 928–930, March 23, 1925.)—If two substances, A and B, are able, when their solutions are mixed, to form an additive compound A_mB_n in equilibrium with its components, the formula of such compound and the equilibrium constant of the reaction yielding it are readily determinable if the concentration of either component or of the compound is measurable. When this is not the case, the composition of the mixture giving the maximum concentration of the compound is constant only when equimolecular solutions of the two components are used and, in general, depends on the concentrations of these solutions and on the value of the equilibrium constant. The latter may, therefore, be determined, provided that the composition of the solution giving the maximum concentration of compound can be ascertained. This should be possible by tracing two spectrograms, one of a mixture of equimolecular solutions to give the formula of the complex, and the other of a mixture of differently concentrated solutions to give the stability of the complex. [See Abstract 1248 (1923).] T. H. P.

1763. *X-Ray Examination of Metallic Alloys.* **H. Lange.** (Ann. d. Physik, 76. 5. pp. 476–492, April, 1925.)—Describes measurements made with the new apparatus constructed by the author, and discusses the errors of the Seemann-Bohlin method as applied to mixed crystals. With gold-copper alloys the variations from Vegard's additive law are smaller than those found by Kirchner (maximum 0·45 % of the lattice constant); they can be ascribed to inhomogeneity of the material. With copper-nickel alloys the variations from the law are about the same as the probable errors of observation, or some 0·2 %. Duralumin was also investigated, both before and after heat treatment. A new lattice appears in the treated metal, the lattice constant of which is a little larger than that of the untreated; this explains the small expansion of duralumin during treatment, and confirms Konno's theory of what happens during treatment, according to which the strengthening of the material is due to similar causes to those effective in carbon steels; the theory of Fraenkel and Scheuer does not agree with the above facts. H. N. A.

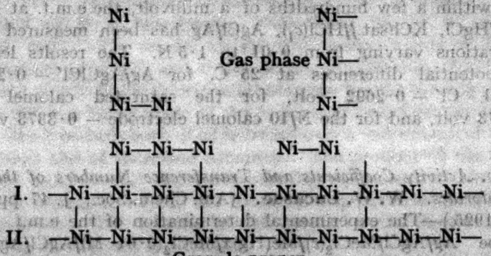
1764. *Heat developed during Plastic Extension of Metals.* **W. S. Farren and G. I. Taylor.** (Roy. Soc., Proc. 107. pp. 422–451, March 2, 1925.)—A method is developed mathematically and applied practically for the comparison of the heat evolved during deformation of a metal with the heat equivalent of the work done on the metal by the forces producing the deformation. A special machine is described in intimate detail, and includes an autographic extensometer recorder. The heat evolved is measured by specially attached thermocouples, whilst the tensile strength is found from the compression of specially calibrated springs. The fullest discussion of all calibrations, errors, etc., is given and a full table of experimental results for steel, copper and aluminium (plain and crystal). The remarkable feature of the table is the constancy of the ratio of the increase in internal energy to the work done on the specimens during different stages of the test. It is the same initially when the metal is soft and hardening rapidly as it is in the last extension when it is quite hard and only hardening slowly. It seems, therefore, that the increase in internal energy does not bear any very direct relationship to the hardening. S. G. B.

1765. *An Investigation of the Temperature Dependence of Reaction Velocity in Solutions.* **C. Wagner.** (Zeits. phys. Chem. 115. pp. 121–129, Feb. 20, 1925.)—The author discusses the connection between the integration constant of the temperature function of the reaction velocity constant in solutions and the conventional chemical constant of gases in solutions of corresponding strengths of the reacting materials. From the interaction of iodo-acetic acid with different inorganic and organic anions (SCN', CN', OH', C_6H_5O', Cl') no simple relationship could be established, although an interpretation of the regularities found has been attempted. In pp. 130–136 the author gives an application of the calculus of errors to the evaluation of the reaction velocity constants with regard to the degree of accuracy of the separate observations, and treats this point entirely mathematically. H. H. Ho.

1766. *New Principle of Equilibrium.* **G. N. Lewis.** (Nat. Acad. Sci., Proc. 11. pp. 179–183, March, 1925.)—The existence of cyclic equilibrium is discussed and shown to be improbable, although the non-existence of such equilibrium would necessitate the discovery of an independent catalyst for each individual reaction or process. The author enunciates the *law of entire equilibrium*, which states that, corresponding with every individual process, there is a reverse process, and in a state of equilibrium the average rate of every process is equal to the average rate of its reverse process. Thus, the rate at which one group or set of groups L passes into another group or set of groups, L′, is the same as the rate at which the groups L′ pass into the groups L. Moreover, if there are various paths by which the former process occurs, there is an equal number of paths by which the latter process occurs, and the rate is the same in both directions along each path. In its general form, this law is not deducible from thermodynamics, but it is found compatible with the laws of thermodynamics in all cases where comparison is possible. T. H. P.

1767. *Decomposition of Hydrogen Peroxide in Presence of Nickelous Hydroxide.* **Suzanne Veil.** (Comptes Rendus, 180. pp. 932–934, March 23, 1925.)—As is well known, nickelous hydroxide decomposes hydrogen peroxide with liberation of oxygen. At the same time the nickelous hydroxide becomes lighter in colour and gradually loses its magnetic properties, which, in the case of the oxides prepared from the hydroxide, at first increase considerably and afterwards slowly diminish. It is evident that the catalyst in this reaction undergoes marked change. T. H. P.

1768. *Theory of Catalytic Surface.* **H. S. Taylor.** (Roy. Soc., Proc. 108. pp. 105–111, May 1, 1925.)—The mechanism of a catalytic action occurring at the surface of a solid catalyst can be studied by several methods. It can be followed from the kinetics of the process, or the surface itself and its properties may be studied. X-ray examination of metallic hydrogenation catalysts show that they possess a definite lattice structure, even when prepared by a low temperature reduction process. The sensitivity of the product to moderate heat treatment, whereby sintering occurs, suggests that the atoms have not attained their completely ordered arrangement, and that groups of atoms exist on the surface of a mainly crystalline granule in which the process of crystallisation is not yet complete. Thus a granule of nickel may be represented in cross-section in an incomplete stage of crystallisation :—


Ni
Ni—
Ni
Gas phase
Ni—
Ni—Ni
Ni—
Ni—Ni—Ni
Ni—Ni
I. —Ni—Ni—Ni—Ni—Ni—Ni—Ni—Ni—Ni—Ni—
II. —Ni—Ni—Ni—Ni—Ni—Ni—Ni—Ni—Ni—Ni—

Granule proper.

The atoms in the second layer of the granule proper will be surrounded on six sides by other nickel atoms. The atoms in the surface will be surrounded by the neighbouring metal atoms in all directions except that towards the gas phase. It follows, therefore, that the uppermost nickel atoms suffer only one constraint by reason of their simple attachment to the nickel atom immediately below. A surface of a granule may be regarded as composed of atoms in varied degrees of saturation by neighbouring metal atoms, varying from those one degree less saturated than the interior atoms to these which are only held to the solid surface by a single constraint. It is by this constraint alone that these outermost atoms differ from gaseous metal atoms. Experimental evidence in support of the above theory of unsaturated catalytic surfaces is discussed. F. J. B.

1769. *Electrodes, Contact, and Electro-Kinetic, Potential of Galvanic Cells.* **J. Heyrovský.** (J. Phys. Chem. 29. pp. 344–352, March, 1925).—A general formula for the electrode potential of metals and metalloids is deduced from a reversible process consisting of energy terms concerning the ionisation of the electrode vapour, the solvation of ions, concentration changes, and transfer of electric charges over the electrode-interphases. The formula is verified from numerical data, all the terms being physically determinable. The contact e.m.f. of metals is shown to constitute only a small fraction of the total e.m.f. of galvanic cells, the largest part of their energy being due to the ionisation and subsequent solvation of the electrode ions. F. J. B.

1770. *Activities of Strong Electrolytes. I. Hydrochloric Acid from E.M.F. of Hydrogen-Silver Chloride Cells. II. Potassium, Sodium and Lithium Chlorides, and Potassium Hydroxide. III. The Use of the Flowing Junction and Revision of Some Simple Electrode Potentials.* **G. Scatchard.** (Am. Chem. Soc., J. 47. pp. 641–661 and 696–709, March, 1925.)—The electromotive force at 25° C. of the cell $PtH_2/HCl, AgCl/Ag$ was measured at different concentrations ranging from 0·01 to 1·5 N, using a rocking hydrogen-electrode vessel designed for use in a water thermostat. The mean activity coefficients of potassium and lithium chlorides have been revised from electromotive force, from freezing-point, and from vapour-pressure measurements, sodium chloride from freezing-point measurements, and potassium hydroxide from electromotive force measurements, taking into account the formation of water in the cell reaction. By the use of a flowing junction apparatus which gives results constant and reproducible within a few hundredths of a millivolt, the e.m.f. at 25° of the cell $Hg/HgCl, KCl(sat.//HCl(c_1), AgCl/Ag$ has been measured with acid concentrations varying from 0·01 to 1·5 N. The results lead to the single potential differences at 25° C. for $Ag/AgClCl' - 0{\cdot}2222$ volt, $Hg/HgCl, Cl' - 0{\cdot}2692$ volt, for the saturated calomel electrode $- 0{\cdot}3373$ volt, and for the N/10 calomel electrode $- 0{\cdot}3373$ volt.

F. J. B.

1771. *Activity Coefficients and Transference Numbers of the Alkaline Earth Chlorides.* **W. W. Lucasse.** (Am. Chem. Soc., J. 47. pp. 743–754, March, 1925.)—The experimental determination of the e.m.f. of cells of the type $Ag/AgCl/MeCl_2(c)/Me(Hg)x/MeCl_2(0{\cdot}01\ M)/AgCl/Ag$, and of the type $Ag/AgCl/MeCl_2(c)/MeCl_2(0{\cdot}01\ M)/AgCl/Ag$, at 25° C., where Me represents Ba, Sr, Ca successively, is described. From the results, taken in conjunction with the calculations of activity coefficients of aqueous solutions of $BaCl_2$ by Lewis and Linhart [see Abstract 779 (1920)], the activity coefficients of $BaCl_2$ from 0·01 to 1·65 M, of $SrCl_2$ from 0·01 to 3·015 M, and of $CaCl_2$ from 0·01 to 3·5 M are calculated. Tables are given including also the kation transference numbers of these salts over similar concentration ranges. A. B. C. L.

1772. *Surface Phenomena in Photovoltaic Elements with a Fluorescent Liquid.* **A. Grumbach.** (Comptes Rendus, 180. pp. 1102–1105, April 6, 1925.)—In a previous paper [see Abstract 2537 (1923)] the author showed that in photovoltaic elements with an absorbent or fluorescent liquid there exists an electromotive force distinct from the Becquerel-effect, and that it is due to a modification of the surface of the electrode which absorbs the dissolved molecules transformed by light. He now gives in a series of tables the results of further experiments with an aqueous solution of the potassium salt of fluorescein. These experiments show that the e.m.f. originates in a transformation of the mass of the liquid produced by the radiation. The consecutive variation of the potential of the electrode is a function of the illumination, of the nature and concentration of the solution, and independent of the initial electric conditions. E. F.

1773. *Moving-Boundary Method for Determining Transference Numbers. III. Novel Form of Apparatus.* **D. A. MacInnes** and **T. B. Brighton.** (Am. Chem. Soc., J. 47. pp. 994–999, April, 1925.)—A simple apparatus is described for the measurement of transference numbers by the method of moving boundaries, a special device being employed for bringing the indicator solutions into contact with the salt solution so as to form sharp boundaries [see Abstract 698 (1924)].

The transference numbers obtained from the ratio, $T_K = \frac{V_K}{V_K + V_{Cl}}$, in which V_K and V_{Cl} are the volumes swept through by the boundaries in which the potassium and chloride ions respectively are leading, are shown to agree, for 0·1 N and 0·2 N potassium chloride at 25°, with values computed from the rates of movement of the separate boundaries. The determination of transference values by the latter method involves measurements of current and time, whereas the determination from the ratio is independent of such measurements. T. H. P.

1774. *Moving-Boundary Method for Determining Transference Numbers. IV. Transference Numbers of Some Chloride Solutions.* **E. R. Smith** and **D. A. MacInnes.** (Am. Chem. Soc., J. 47. pp. 1009–1015, April, 1925.)—The results are given of measurements of the transference numbers of 0·1 N and 0·2 N potassium chloride, 0·1 N sodium chloride, and 0·1 N hydrochloric acid solutions by the moving-boundary method at 25°, use being made of the apparatus described [see preceding Abstract], which permits both of adjustment over a wider range of indicator concentrations and of increased accuracy. The product of the chloride-transference number and the corresponding equivalent conductance is found to be constant, within the limits of experimental error, for the above substances. The bearing of this result on the theory of ionisation of strong electrolytes is discussed. T. H. P.

1775. *The Migration of Ions in Solid Electrolytes.* **C. Tubandt** and **H. Reinhold.** (Zeits. Elektrochem. 31. pp. 84–88, Feb., 1925.)—In a previous communication, the authors showed that for strong electrolytes only one ion appeared to be free to move, which could not be explained on the usual conceptions of crystal structure; recently le Blanc and Kröger [see Abstract 2613 (1924)] explained this phenomenon by assuming that the ion whose migration involved the least expenditure of work was the one free to move, quoting the authors experiments with AGI and $PbCl_2$ in support of their view. Reference to further experiments carried out by the authors using Pt cylinders for electrodes instead of silver shows this view to be untenable; in all cases, for any given compound, the same ion always migrates, however the conditions of current, etc., are varied, and with mixtures of electrolytes the same effect is observed, although the process may involve the expenditure of work in the formation of other compounds. B. W. C.

1776. *Overvoltage and Transfer Resistance.* **E. Newbery.** (Roy. Soc., Proc. 107. pp. 486–495, March 2, 1925.)—An investigation by means of a kathode-ray oscillograph of the variation of the value of the single potential difference at a kathode immersed in an electrolyte, during make and break of the current, indicates that transfer resistance is a real quantity, which may under certain conditions be as great as 100 ohms per sq. cm. Its value decreases with increasing current density. The direct method of measuring overvoltage is unreliable, as the value so determined includes not only the true overvoltage, but also the drop of potential across the variable transfer resistance. The commutator methods gives reliable results, provided results obtained with different commutator speeds are extrapolated to an infinite speed, but with certain kathodes speeds equal to at least 100 commutations per sec. must be employed. The phenomena observed are explicable on the hydride theory of overvoltage. [See Abstract 1967 (1924).] J. S. G. T.

1777. *Thermocurrents in Electrolytes.* **J. Thièle.** (Phys. Zeits. 26. pp. 321–329, April 30, 1925.)—When a galvanic cell is constructed on the following scheme,

$$\text{Platinum}/\underset{\text{hot}}{\text{CdI}_2}//\underset{\text{cold}}{\text{CdI}_2}/\text{Platinum}$$

a current flowing from the hotter side to the colder side is to be expected. Experiments were made in which various solid salts were kept in contact with platinum electrodes and maintained at different temperatures. The current generated was measured and its direction observed. It was found that for the solid halogen salts of cadmium, lead, thallium copper, silver, and for sodium and potassium nitrate the current flowed from the hot to the cold junction through the electrolyte. The halogen salts of mercury did not show any thermocurrents. Irreversible cells with solutions of the salts showed a reverse direction of current than with the solid salts. F. J. B.

1778. *Conductivity of Electrolytes.* **C. W. Davies.** (J. Phys. Chem. 29. pp. 473–481, April, 1925.)—The theory of Arrhenius is unable to explain the way in which the conductivity of a "strong" electrolyte changes with changing concentration. Debye [Abstract 2541 (1923)] has treated the question mathematically on the assumption that the diminution in electrical conductivity with increase of concentration is due to the electrical force which exists between the ions. It is shown that the postulate of complete dissociation is in complete harmony with experimental data for very dilute aqueous solutions of univalent electrolytes, and an empirical relationship is advanced which expresses the conductivity of such a solution in the terms of the concentration, c, the mobilities of the ions present, A_0, for infinite dilution and Λ_c for the concentration c, and a universal constant K. The theory is also extended to multivalent electrolytes. F. J. B.

1779. *Electrolytic Calcium Amalgam from Aqueous Calcium Hydroxide. Normal Potential of Calcium.* **A. Eilert.** (Zeits. Elektrochem. 31. pp. 176–180, April, 1925.)—The electrolysis of aqueous solutions of calcium salts with a mercury kathode yields at the best an amalgam with 0·09 % of Ca because the amalgam formed is decomposed and the electrolysis interrupted by the deposition of solid $Ca(OH)_2$ on the mercury. By keeping the electrolyte of $Ca(OH)_2$ in constant circulation, so that both the kations and anions (reacting with the Ca deposited) are removed, the author and K. Wissel (Dissert., Brunswick, 1924) obtained an amalgam with 2·4 % of Ca. The mercury covering the bottom of the glass cell must be free of water, and there must be no moisture film between the mercury and the glass; the solution of calcic hydrate must not be turbid with undissolved $Ca(OH)_2$. The mercury is transformed into a crystalline mass which can be compressed to enrich it in calcium; the crystallisation begins in the interior of the mercury. The deposition potential of calcium is $\epsilon_h = -1{\cdot}85$ volts. From potential measurements made in cells consisting of the amalgam /$CaCl_2$ in methyl alcohol/ the same and Hg_2Cl_2/Hg, the normal potential $\epsilon_0 Ca = -2{\cdot}57$ volts is deduced, which agrees with Wilsmore's value $-2{\cdot}56$. H. B.

1780. *Electrolysis of Crystals.* **P. Lukirsky, S. Ščukareff** and **O. Trapesnikoff.** (Zeits. f. Physik, 31. 7–8. pp. 524–533, 1925.)—The investigation was undertaken to determine the nature of the conduction of electricity by crystals. Previous work had shown that solid crystals had a conductivity depending upon ionisation, but in the case of sulphides the conductivity was probably electronic [see Abstract 323 (1924)]. A series of measurements were made on the conductivity of crystals of common salt and sylvine, KCl. Crystals of the salts from 2 to 4 c.c. were polished, and pressed between the metal electrodes, which in turn were clamped between two steel plates, the plates being insulated from the electrodes by means of mica. A current from an accumulator battery at 300–3000 volts was used, and temperatures of 300°–600° C. were maintained in a specially designed heater. A silver voltameter was placed in series with the crystal, and the precipitated silver was estimated by weighing and by titration. The electrodes and the crystals were weighed before and after the passage of the current. Microscopical examination of the crystals showed dendritic growths of sodium, extending some millimetres into the crystal. An explanation of the conductivity of the crystals on the ground of the space lattice and movement of ions is given. F. J. B.

1781. *Electrolysis of Salts of Alkyloxyacids.* **D. A. Fairweather.** (Roy. Soc. Edinburgh, Proc. 45. 1. pp. 23–33, 1924–1925.)—The behaviour of the salts of alkyloxyacids on electrolysis was studied. It was thought that it might be possible to ascend the series of dibasic hydroxyacids (*i.e.* tartronic, tartaric, mucic, etc.) by electrolysis of the potassium ethyl salts of their alkyl derivatives, in an analogous manner to the synthesis of the normal dibasic acids. The potassium ethyl salts of ethoxymalonic and symmetrical *d*-diethoxysuccinic acids were prepared and their aqueous solutions were electrolysed. The electrolysis of salts of ethoxyacetic and amyloxyacetic acids was repeated and the resulting products were investigated. Tartaric acid was synthesised by the electrolysis of potassium ethyl ethoxymalonate and de-ethylation of the ethyl diethoxysuccinate. The chief products of the electrolysis are of an aldehydic nature, and their formation is probably not due to oxidation. F. J. B.

1782. *Electrolysis with a Gas Kathode.* **A. Güntherschulze.** (Zeits. Elektrochem. 31. pp. 187–189, April, 1925.)—Experimenting in 1887 with a discharge tube, the anode of which was an aqueous solution of silver nitrate and the gas water-vapour, Gubkin observed the formation on the surface of the electrolyte of a disc of silver, on which rings developed. The author repeats these experiments by filling a porcelain dish with an electrolyte, dipping a wire wrapped with filter paper into it, and suspending a platinum dish (filled with wax to keep the dish cool) 1 or 2 cm. above the liquid; the whole is placed in the recipient of an air pump and cooled externally with ice. The positive current direction is: wire, electrolyte, gas space, platinum; the gas is the kathode of the electrolyte. Using various electrolytes he did not observe any metallic deposits; copper sulphate, alone or mixed with sodium sulphate, gave some green hydrate, lead nitrate some PbO; silver nitrate and mercury nitrate yielded no deposits at all, nor did acid or cyanide solutions of copper salts. The author suggests that the electrolysis with a gas kathode differs from that with a metallic kathode, because the few electrons from the gas space are not stopped by the surface of the liquid electrolyte and do not set up strong fields at the surface. H. B.

1783. *Influence of Alternating Currents upon Polarisation in Metal Deposition.* **N. Isgarischew** and **Sophie Berkmann.** (Zeits. Elektrochem. 31. pp. 180–187, April, 1925.)—The salts studied are nickel ammonium sulphate and zinc sulphate (neutral or acid). Two phases of three-phase currents are superposed on d.c. The cell contains an anode of the respective metal, a ± electrode of platinum coated with the same metal, an auxiliary electrode, a stirrer and a tube for passing hydrogen through the electrolyte. The kathodic polarisation curves indicate that at least two simultaneous processes have to be distinguished, the deposition of hydrogen and of nickel. The a.c. seems to influence particularly the hydrogen liberation; the positive H ions discharged may be recharged by the a.c. and the polarisation thus be promoted. With increasing a.c. potential more oxygen is liberated at the kathode, and the polarisation is decreased. The presence of gelatin increased the polarisation, especially at high frequency (150). The effects were less marked and clear in the case of the zinc sulphate than with the nickel salt. H. B.